

Illuminating the Black Sands:

Survey and Settlement in the Bronze Age Murghab Delta,
Turkmenistan

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I, Steven Brett Markofsky, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

Abstract

This thesis examines the Bronze Age settlement distribution in the Lower Murghab Delta, Turkmenistan. The delta represents a visually obstructed landscape in which the reconstruction of past archaeological patterns is extremely difficult. Drawing on concepts of distributional archaeology and ‘siteless surveys’, the research focuses on the distribution of surface pottery as the primary dataset in an examination of local and regional settlement distributions and their significance with respect to the proto-urban landscape of the delta. The survey data is assessed within the context of past and present landscapes, examining issues of visibility and recovery potential en route to a better understanding of the archaeological significance of the Bronze Age settlement pattern.

While the central trajectory of the thesis is to address these issues, a secondary goal is to examine the nature of survey itself in the region. The field results are therefore considered in light of earlier Soviet/Russian and Italian research in the Murghab, assessing the effectiveness of that work and the research potential of intensive survey in the region. In addressing these questions, newer methodologies that incorporate spatial analysis and remote sensing data are examined, both on their own merits and as adjunct methods to support field survey. Ultimately, these questions are synthesised in order to examine the relationships between surface distributions and the landscape, and ultimately to better understand settlement phenomena in the northern Murghab.

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Chapter 1. Introduction

1.1. Overview

In November 2006, amid much national fanfare, a major international conference was held at the major Bronze Age site of Gonur Depe in the former Soviet republic of Turkmenistan. The key message of the conference, and ultimately its slogan, was that the Bronze Age region known locally as ‘Margush’ was at long last worthy of the appellation of a ‘New Centre of World Civilisation’ (State Information Agency of Turkmenistan 2006). This ‘Centre’, it was proclaimed, rivalled those of Mesopotamia, the valleys of the Nile and Indus, and China. The festive and somewhat chaotic atmosphere accompanying this proclamation largely overshadowed the theoretical and scientific goals of the conference—not least the significance of what the discovery of a ‘previously unknown civilisation’ might signify (G. Joraev, pers. comm.). This symbolic certification of the ancient Murghab delta as a ‘Bronze Age Civilisation’, a full century after the first known prehistoric sites in the region were visited by Raphael Pumpelly in the Kopet Dag foothills (Pumpelly 1908), is illustrative of the multiple layers of inscrutability that have long veiled this important part of Turkmenistan’s prehistory.



Figure 1. Central Asia. NASA Blue Marble Imagery
(<http://earthobservatory.nasa.gov/Features/BlueMarble/>)

To many people in Turkmenistan, Gonur Depe and Margush are synonymous concepts: the culture is completely defined by the site. It is not difficult to see how such a notion may have originated. Remotely situated in a relict part of the delta of the Murghab River, or Margiana in its Hellenistic nomenclature (Rossi-Osmida 2007: 3), Gonur Depe is an anomaly (Figure 1). Here, towards the end of the 3rd millennium BC and for reasons that are still not clear, a highly distinctive cultural tradition appeared, apparent in many elements of its material culture. Aspects of this unique identity included new ceramic forms, intricate stone and metalwork, zoomorphic and geometric iconography and, perhaps most conspicuously, a new form of highly stylised geometric architecture (Hiebert 1994a: 2). The depth of its material culture, reinforced by the dominant scholarly opinion of Victor Sarianidi (e.g. 1990; 2002; 2005), the archaeologist who discovered the site, has enshrined Gonur both in public and academic consciousness as the type-site for an extraordinarily rich, intriguing, and elusive culture.

In reality, site and culture are rarely synonymous. While Gonur is certainly the largest known Bronze Age settlement in the Murghab delta, and the richest in terms of the diversity and craftsmanship of its material (Sarianidi 2005), it is only one of hundreds of sites in the region, the vast majority of which remain unexplored. Several of the excavated sites, however, have revealed material and architectural similarities, and based on the distinctiveness of the material in the Murghab as well as the near-concurrent appearance of a similar material culture as far away as the region known as Bactria, comprising southern Uzbekistan and northern Afghanistan, Sarianidi has proposed a single complex for the entire region (Sarianidi 1990: 74). This cultural entity, which he refers to as the Bactria Margiana Archaeological Complex (BMAC), has become a pervasive concept in the archaeological literature. However, in the rush to interpret the specific cultural phenomenon of the BMAC, with its perceived cultural uniformity, its rapid rise to prominence and the extent of its influence, archaeologists have in many ways missed opportunities for a fuller study of the Bronze Age in general, of which the BMAC represents only one aspect.

1.2. Barriers to Archaeological Research in Turkmenistan

The path to a clear interpretation of the Bronze Age in the Murghab delta has been in many respects even more labyrinthine than is usual in archaeological investigations. Perhaps the most obvious complication is a political one. Turkmenistan is not an easily accessible country, and bureaucratic issues may plague even well-established projects. Moreover, even two decades after the fall of the Soviet Union, vestiges of the Iron Curtain still remain. Academia was not immune to the tensions of the Cold War, and even when academic paths finally crossed in the mid-1980s, aided by the new spirit of camaraderie during the *perestroika* era (Lamberg-Karlovsky, foreward, Hiebert 1994a), the disconnect in methods and interpretations remained a formidable impediment to collaborative research. Compounding this disconnect was a significant linguistic barrier. Although Russian and Central Asian archaeologists published an enormous body of research, the difficulty of the Russian language and the impediments to obtaining the relevant sources relegated this work to the isolated sphere of Soviet scholarship rather than fostering a fruitful academic discourse with archaeologists outside the USSR (Lamberg-Karlovsky 2003). Even within collaborative projects today, vestiges of Soviet-Western duality in both theory and method remain pervasive. Theoretical interpretations during the Soviet era were drawn largely from Marxist ideologies, and the consequent focus on the development of stratified class structures within prehistoric society largely informed theoretical debate with respect to urbanism and complexity (Diakonoff *et al.* 1991; Kohl 2007; McGuire 1997). Methodologies, as well, varied widely between West and East, and different approaches to C¹⁴ dating have resulted in substantial chronological differences, often spanning a half-millennium, although reconciliation between Russian and Western calibrations has increased in recent years (Kohl 2007: 19).

Political and academic barriers, however, have not been the only impediments to an understanding of the Murghab Bronze Age. Poor site visibility is a major problem in the region (see section 1.8.4), attributable to several factors. The explosion in urban and agricultural development in the past several decades, largely precipitated by the construction of the Karakum Canal in the 1950's and 1960's, has obliterated many archaeological sites and severely restricted the recovery potential of others. Another problem is that the aggradation of the Murghab River in antiquity has resulted in alluvial deposition which may be several metres deep in much of the delta (Cremaschi 1998: also see section 1.8.4). Further north where the alluvium may be expected to be less thick and agriculture less pervasive, sites may be easier to see, although these

are often severely deflated (Hiebert 1994a: 6). Moreover, heavy dunes cover much of the landscape, presenting an additional barrier to site visibility (Cattani et al. 2008: 42).

1.3. Overview of Research in the Murghab delta

Research into the Bronze Age in the Murghab has largely proceeded at one of two conceptual levels which may be considered macro-scale and micro-scale. At the macro-level, the grand surveys conducted under the auspices of the Southern Turkmen Archaeological Expedition (YuTake) in the 1940s and 1950s recalled S.P. Tolstov's highly influential work in Khorasmia (Tolstov 1948), a prescient body of research that examined not only settlement but also its significance in the context of complex fluvial landscapes (see also Adams' praise of this work (Adams 1965)). As a result of the YuTake surveys, many new sites were discovered along the foothills of the Kopet Dag mountains and as well as the Murghab delta, effectively placing the Bronze Age civilisations of the region on the archaeological map (Masson 1988: 1). Development of these societies was seen by many researchers to follow similar trajectories, and the pottery sequence from the foothill site of Namazga Depe (Figure 2) has remained the prevailing chronological framework for much of Central Asia for over a half-century with Namazga periods IV, V and VI representing the Early, Middle and Late Bronze Ages respectively (Masson 1988: 1; Masson and Sarianidi 1972). It should be noted that these subdivisions of the Bronze Age are specific to the sedentary sites in west Central Asia, and reflect a general trajectory of urbanism as interpreted from the Namazga chronologies. The terminology has been used by prominent researchers (e.g. Kohl (1984); Masson (1959); Sarianidi (1990); Salvatori (1998)), and is incorporated here for consistency and as a means to distinguish different processes in evidence in the current research. The Namazga terminology is used when describing specific chronological horizons or material characteristics.

	4800 BC	4000 BC	3500 BC	3000 BC	2500 BC	2000 BC	1500 BC
Central Asia	Namazga I	Namazga II	Namazga III	Namazga IV	Namazga V	Namazga VI	Yaz I
	'Eneolithic'	Chalcolithic		Early Bronze	Middle Bronze	Late Bronze	Iron Age I
Sistan	Mundigak I	Shahr-i-Sokhta I	Shahr-i-Sokhta 2	Shahr-i-Sokhta 3-4			
S. Mesopotamia	Ubaid	Uruk	Jemdet Nasr	Early Dynastic	Akkadian	Ur III Isin/Larsa	Babylonian

Figure 2. Namazga chronological horizons

In the Murghab delta itself, several sites had already been identified as part of the YuTake research by the middle of the last century, the northernmost of which was Auchin Depe in the northeast portion of the palaeodelta (Kohl 1984: 143; Masson 1956: 250). However, the full scope of Bronze Age settlement in the region only began to come to light as a result of the surveys of the Margiana Archaeological Expedition (MAE) in the 1970s and early 1980s, led by Victor Sarianidi and I.S. Masimov (Sarianidi 1990). These surveys, while more exploratory than systematic, resulted in the development of an initial map of Murghab settlement and facilitated a preliminary understanding of the archaeological landscape (Figure 3). Recalling Aurel Stein's explorations a half-century earlier in the hyper-arid oases of the Tarim Basin (Stein 1921; 1925), the causes and interpretations of settlements in 'oasis' environments were prominent theoretical questions (for discussion see section 2.4). In this vein, sites in the Murghab were generally described as occurring in distinct and isolated settlement groups, or 'micro-oases' (Hiebert 1994a: 39). Within each purported micro-oasis, sites were named after wells in the vicinity, with successive numbers (e.g. Adji Kui 1,2,3) assigned in order of discovery.¹ Although these designations are arbitrary and bear no relation to actual boundaries that may have existed in antiquity, this naming scheme has largely affected the perception of the settlement structure in the delta, creating interpretative associations and discontinuities where none may have existed.

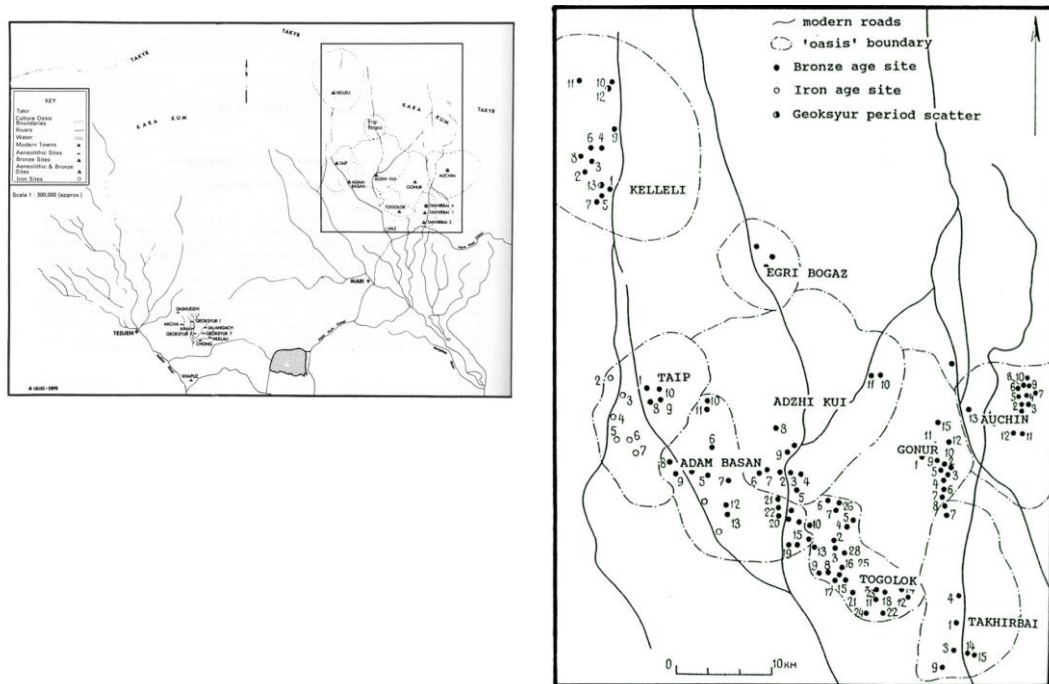


Figure 3. Bronze Age Sites of the Murghab delta (after Kohl 1984: 145, Map 16B) (reprinted with permission)

¹Togolok 21 is an exception and was arbitrarily assigned by Sarianidi.

For the purpose of this research, and broadly in keeping with terminology employed by other scholars, the relict Bronze Age delta is here divided up into the ‘northern delta’, ‘central delta’ and ‘southern delta’ (Figure 4). The modern delta, quite different from the ancient one in its orientation (see section 1.8.2), is here referred to as the ‘modern delta’ or ‘Merv oasis’. The northern delta comprises the sites of the Kelleli and Egri Bogaz groups and is often associated with the earliest phase of settlement in the region (Kohl 1984: 143, also see Section 2.4.1). The central delta comprises the complexes of Taip, Adji Kui, Adam Basan and Gonur, while the Togolok and Takhirbai groups comprise the southernmost of the Bronze Age settlement groups. South and west of this region lies the heavily cultivated modern delta. Here, significant evidence of Bronze Age occupation is no longer apparent, a factor that may be due in part to overlying alluvial sediments but likely exacerbated by destruction caused by intensive agriculture and urbanisation activities (see Section 1.8.4).

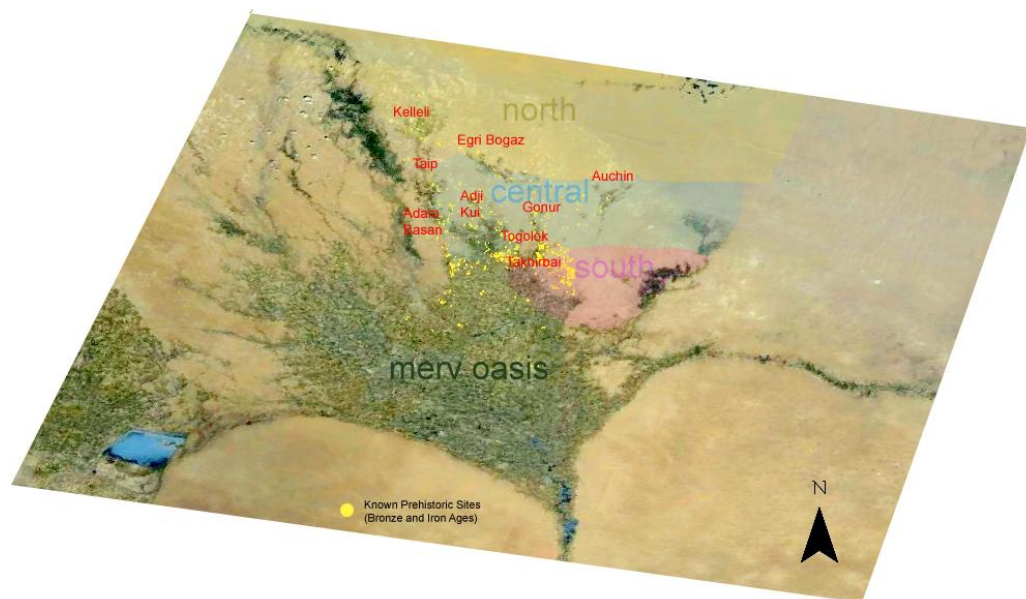


Figure 4. Regions of the Murghab delta

The most significant modifications to the known archaeological map over the past two decades have come as a result of recent research conducted under the auspices of the Archaeological Map of the Murghab delta (AMMD), a joint project conducted by the University of Bologna along with institutions in Russia and Turkmenistan (Bondioli and Tosi 1998). In addition to adding hundreds of sites to the regional map, these integrated projects have sought to bring a more systematic approach to survey and settlement analysis, and ultimately to foster a better understanding of the relationships between settlement, hydrology and irrigation. Their research

has culminated in a much clearer understanding of the geomorphology of the palaeodelta and diachronic changes in settlement patterns from the Middle Bronze Age through the Islamic period (Cattani and Salvatori 2008).

Punctuating these large-scale surveys has been a series of much more targeted investigations, the micro-scale of Murghab research. These have generally focused on large sites with monumental architecture although some investigations into finer aspects of local stratigraphy and domestic contexts have been conducted (e.g. Hiebert 1994a: 29-38; Salvatori 2002; Cattani *et al.* 2008b). Several of these investigations have developed into major, multi-year or even decades-long excavations oriented towards the full horizontal exposure of monumental structures—and in some cases entire cities (Sarianidi 1990; cf McGuire 1997: 59-62). While some of the more recent projects have addressed more localised settlement landscapes and off-site pottery distributions (see Cleuziou *et al.* 1998), these have been small-scale investigations, several of which are only at a preliminary stage of analysis (B. Cerasetti, pers. comm.). The disconnect between these two scales of research has resulted in a kind of interpolated understanding of the Murghab Bronze Age, where concentrated pockets of incomplete site data have been draped against a poorly understood regional backdrop. The results of such guesswork can be seen in the myriad of conflicting theories surrounding the origin, development, and decline of complex societies in the Murghab delta (see section 2.3.2., also P'yankova 1994).

This focus on a few archaeological places of interest within the vast landscape of the Murghab delta highlights a lack of understanding at any number of regional levels. Largely absent from research agendas has been the investigation of the smaller communities that might clarify the nature not only of occupation, but also of settlement interaction. Indeed, sites beyond the immediate boundaries of the larger centres have received scant attention in the literature, and V.M. Masson treats these sites somewhat dismissively as small, non-urban entities that ‘do not usually present traces of commercial activity’ (Masson 1999: 342). When they do appear in the literature, the descriptions are often limited to approximate measurements of the extent of surface scatter, identification of occasional architectural or production features, and any small finds that occur in the vicinity (e.g. Sarianidi 1990; Udeumuradov 1993). The extreme under-emphasis on these smaller sites has yielded a lopsided interpretation of the Murghab drawn largely from the excavation of a few substantial sites, Gonur Depe foremost among them.

1.4 *The Northern Murghab and the Egri Bogaz Sites: Introducing the Research Agenda*

If the Murghab as a whole is reluctant to yield its secrets, the northern delta is practically mute. With the exception of two significant excavation programmes in the Kelleli region in the late 1970's and early 1980's (Udeumuradov 1993: 13-14; Masimov and Kohl 1981), research in the north has been sporadic as archaeological interest has focused on the more accessible sites in the central and southern regions of the ancient delta. Moreover, if the recent maps are any reflection of archaeological reality, much of the region appears to be almost completely devoid of Bronze Age occupation. While hundreds of new sites have been identified in the delta over the past two decades, fewer than a dozen have been added to the known archaeological landscape in the north (see appendices in Bondioli and Tosi 1998). This lack of knowledge, however, does not mean that the northern Murghab has completely fallen below the radar of current research. The initial plan of the AMMD investigations, in fact, had incorporated substantial work in the northern delta. Unfortunately, while the region was recognised as potentially integral to the study of the relationships between Murghab settlement and landscape, the visibility in the north was largely written off as too obtrusive to offer a clear view of settlement factors in this region (Cattani and Salvatori 2008). Nonetheless, a series of transects was conducted in the region that shed some light on the extent of the distribution of material and occupation (see sections 2.4.2 and 7.4). AMMD researchers returned to the north in 2009, this time conducting a small-scale but intensive survey of the Auchin region (B. Cerasetti, pers. comm.). Unlike earlier investigations in this region, this work has focused much more on spatial patterning and the distributions of surface material. While analysis is preliminary and remains unpublished, it may substantially improve the understanding of settlement in the northeastern portion of the delta.

Essentially, then, an enormous region of potential archaeological interest has been limited to a few concentrated studies in the northwestern and northeastern portions of the palaeodelta, pockets of investigation separated by nearly 50 km. Between these, with the exception of the few additional sites discovered by the AMMD surveys noted above, the known archaeological landscape is almost empty, with one conspicuous exception. About halfway between the Auchin and Kelleli areas lie the few isolated sites of the Egri Bogaz group, anomalously located in what appears to be, for all intents and purposes, the middle of nowhere. Very little is known about these communities, and with the exception of their locations and a few isolated small finds (Salvatori 2008a), almost nothing has been published. These sites have variously been associated with the Middle or Late Bronze Age, and Udeumuradov has suggested that they may

represent a transitional phase between the earlier ‘Kelleli’ phase, associated with the Middle Bronze Age, and later occupations (Udeumuradov 1986, cited in Hiebert 1994a; Kohl 1984: 143). Evidence for such dating schemes is extremely limited, however, based on cursory investigations of small-scale excavations and surface material, and discussions pertaining to chronologies will be revisited in later chapters. The poor understanding of the archaeology in the Egri Bogaz region is therefore unfortunate, since the presence of substantial archaeological material in a pivotal location between Kelleli and the central delta suggests that this area may reveal important information about regional settlement and its relationship with the better-known sites further south. Equally important is what the apparent settlement gap may say about the region, and whether it represents a true absence of occupation in the northern Murghab or is instead due to issues of poor visibility or lack of investigation.

Such inquiries, in order to be successful, require a significant understanding of the complexities of the landscape both ancient and modern, and this thesis builds upon a substantial foundation of research devoted to understanding the nature of the geomorphology, land cover and soils in the delta. In this vein, Suslov’s seminal work (1961) provides a broad understanding of the geomorphological character of the Karakum in the context of the diverse Central Asian landscapes. Of particular interest to the current study is the character of the local geomorphology, particularly the soil crusts known as *takyr*s (see description in section 1.8.3). The genesis and development of these soils were the subject of several influential investigations by N.I. Bazilivich (1956), and the refinement of subsurface profiles has recently been conducted by Lebedeva-Verba and Gerasimova (2010). From an archaeological perspective, Lisitsina (1973; 1976) and Lyapin (1991) have examined these features with respect to subsurface archaeology, and each has provided comparative studies centred on the Murghab and Tedjen deltas (also see sections 1.8.2 and 7.9). From the perspective of irrigation, the effects of salinisation on agricultural potential have been explored by researchers such as Lavrov and Kostyuchenko (1954). Anthropogenic effects of both pastoralism and agriculture (Fleskins et al. 2007) have been examined in the region, and these will be further addressed in Chapters 5 and 7. More recently, researchers associated with the Institute for Desert Research in Ashgabat and the Ben Gurion Institute in Israel have incorporated remote sensing technologies to examine these landforms in the Karakum (e.g. Orlovsky *et al.* 2004). The current research seeks to deepen these understandings and provide a closer look at the relationships between these features and the surface distribution of Bronze Age material.

At issue, however, is the definition of both a scope of research and a starting point for analysis. Egri Bogaz represents a largely unknown region in a largely unknown landscape, so it is essential to assess not only the degree to which such a region may be expected to provide answers to research questions, but how to ask such questions in the first place. If a more conventional, ‘top-down’ model were to be followed, one approach may be to systematically survey an extensive region of the northern delta (see section 2.6). However, it is not clear that such an approach would substantially broaden what the Russian and Italian surveys have already contributed to our knowledge of the area. While the broad scope of settlement in the north is certainly not yet known, there is much to be learned at narrower analytical scales—about local and regional settlement interaction, material distribution, and survey potential that may only add to the understanding of patterns of occupation in the north, but that lends itself well to the limited scope and resources of doctoral research. Studies at these smaller scales are sorely lacking in the Murghab, and are essential to understanding settlement integration, not just settlement location.

With respect to a specific study location, it is essential to select an area where archaeological information is likely to exist: a ‘stab in the dark’ in this largely unexplored landscape is not a viable option. The wealth of surface material recovered throughout the Egri Bogaz region therefore implies a promising study area. While the research is not an investigation of a single archaeological site per se, it centres on the landscape surrounding the northernmost and one of the more recently discovered sites in the region, Egri Bogaz 4 (references in Bondioli and Tosi 1998: appendices, AMMD GIS system and Turkmen Ministry of Culture documents: see Chapter 5). Unlike the other Egri Bogaz sites, Egri Bogaz 4 has not been affected by agricultural development. Additionally, the varied landscape and presence of substantial scatters of surface material over a large region, several of which have been designated as separate sites, offer an excellent research context in which to explore variability both in landscape and occupation. This research is thus not the study of a site but of a settlement landscape, intended to chart a middle course between the macro- and micro- extremes in interpretive scale outlined above. Through intensive field survey, the research focuses on settlement patterns at scales that fall between site and region, in what may be considered an investigation of sub-regional settlement patterning and interactions.

1.5. Research Questions

The research described in this thesis is hereafter referred to as the Northern Murghab Delta Survey (NMDS), of which the central research question may be stated as follows:

How, in a highly obstructed archaeological landscape, can intensive survey be used to investigate the archaeological and post-depositional processes that shaped the distribution of surface material in the northern Murghab, and to what extent can such a survey contribute to the broader understanding of settlement dynamics in the delta region?

In order to address this question more fully, the research may be further broken down into a set of investigative goals that centre on the conjunction of spatial and scalar investigations within a complex and variable landscape:

- What is the relationship between settlement and the distribution of material in the northern Murghab?
- How may these relationships be used to explore the role of this region with respect to broader settlement structure in the Murghab?
- To what extent can intensive survey provide a better understanding of local and regional interactions between settlements? Are settlements best treated as isolated entities or as part of an integrated settlement hierarchy? Might a different model be more applicable?
- To what extent can agricultural or economic strategies be inferred?
- How can we better understand the concept of 'site' with respect to surface scatters in the northern Murghab?
- To what extent can spatial analysis and remote sensing be used to supplement survey in the Murghab, and perhaps elsewhere in Central Asia?
- How effective have previous surveys been in exploring the nature of Murghab settlement and how may they be improved?

In this reconciliation between the understanding of regional complexity in the northern Murghab and field survey at the conceptual level, my research incorporates three distinct yet closely related analytical frameworks: spatial distribution, scale and landscape. While any of these alone could certainly serve as the subject of intensive study, the convergence of these concepts is a powerful means to understand an almost entirely unknown archaeological landscape. In order to bring these disparate approaches together, this study makes use of a range of technological

and statistical tools in addition to field survey, detailed in Chapter 3. Ultimately, it has become possible to examine the concept of ‘site’ itself as it pertains to Bronze Age occupation in the Murghab, and to offer a much deeper perspective on the Bronze Age settlement landscape.

1.6 *Structure of Thesis*

In following this trajectory, the remainder of this chapter provides a general overview of the study area. Chapter 2 then presents several of the theoretical questions that have guided both past and present research in the region. The second part of the chapter entails a theoretical assessment of the methodological approaches. These methodologies are described in detail in Chapter 3. Chapters 4 through 6 comprise the bulk of the research results, and are structured to develop an integrated theme of survey within a landscape: Chapter 4 presents the results of the remote sensing analysis, and evaluates its implications in terms of visibility and site and landscape interpretation. Following this exposition on the survey environment, Chapter 5 then presents the results of the fieldwalking survey as well as a discussion on the material remains. A spatial perspective is introduced in Chapter 6, which draws on statistical interpretation to further explore the data from the previous two chapters. Analysis and discussion of the results comprise Chapter 7, which endeavours to integrate the main themes of spatial patterning, scale and landscape in a discussion of the archaeological significance of the settlement pattern. The final chapter takes a step back, assessing the results of past and present survey work, the limitations of these projects, and their ultimate implications for understanding settlement in the delta.

1.7. *Limitations*

This research is largely exploratory in nature, designed to gain insights into a portion of the Murghab delta that continues to elude research agendas. Ultimately, this thesis is primarily about settlement, and the degree to which intensive survey can address questions concerning occupation and complexity of the settlement pattern. To this end, and keeping in mind the difficult terrain with respect to archaeological visibility and overall accessibility, the research employs several very different but interrelated techniques, outlined in detail in Chapter 3. Each of these could alone constitute years of research. However, in an effort to address a major gap in the knowledge of the region, the methods are employed as tools to supplement the primary dataset provided by the survey itself, both in planning and analysis.

With respect to the choice of a survey location, Egri Bogaz 4 may seem at first to be an odd selection. As noted above, very little is known about the site itself. Although classified as a 'site', Egri Bogaz 4 is defined only by surface scatters and the presence of a mound in the vicinity although, as will be seen in later chapters, the relationship between scatter and topography is far from clear. Clearly defined limits of occupation, architecture, production or consumption areas—all are absent. Although inferences may be drawn from knowledge of other sites in the Murghab, as well as the few surface artefacts already collected in the area, Egri Bogaz 4 remains unexcavated, and great caution and scepticism must be used when attempting to draw conclusions from surface distributions. However, these challenges bolster the choice of this region for a study of a small-scale archaeological landscape. Without overwhelming preconceived notions of what settlement patterning should look like in the northern Murghab, the material distribution can more easily speak for itself, allowing patterns to be interpreted rather than determined by known settlement entities. Moreover, the better-known settlement areas of Kelleli and Auchin are further away from the central delta than Egri Bogaz, and less suited to a more integrated assessment of how a small-scale settlement pattern may fit into a larger deltaic one. Furthermore, the apparent isolation of the region on the known settlement maps may offer clues not only to the settlement patterning, but to the nature of archaeological recovery in a complex environment.

1.8 *Geology and Climate of the Murghab delta*

1.8.1. Geological Setting

The endorheic or inland delta of the Murghab River (Figure 5) is situated in a broad geologic basin that gradually slopes downward from the Amu Darya River in the northeast to the Kopet Dag mountains in the southwest (Marcolongo and Mozzi 1998). This immense depression is dominated by the Karakum Desert, a vast, arid region that comprises approximately 80% of the land mass of Turkmenistan (Orlovsky *et al.* 2004; Babaev *et al.* 1994). North of the Karakum extend the open steppes of northern Central Asia, while elsewhere the desert is bounded by an arc of mountain ranges. To the southwest, the Kopet Dag range straddles the Iranian border, and the myriad of small, rain-fed rivers that propagate from these highlands served as the life-blood for sedentary communities as early as the late 7th millennium BC (Hiebert 2002). Far to the southeast, across the Bactrian Plain, rise the Parapomissus Mountains, the westernmost arm of the formidable Hindu Kush range and the source of the Tedjen and Murghab rivers.

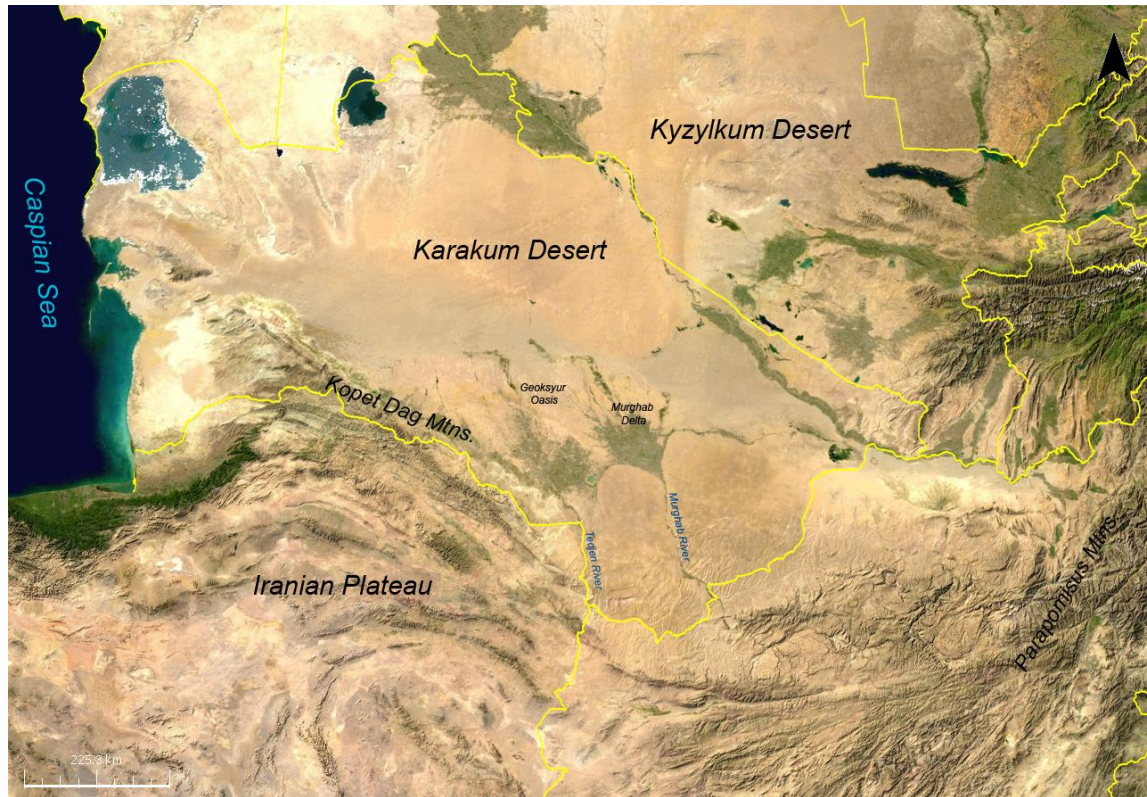


Figure 5. Regional Topographic Map of Central Asia (NASA Blue Marble Imagery)

Fed primarily by winter and spring rains (Sala 2007), the Murghab River flows for approximately 850km from its source in the Parapomismus before losing its waters in the sands of the Karakum Desert. For much of its course, the river flows through a deeply-cut channel, a feature that has ensured the river's stability for millennia (Cremaschi 1998). This incision, however, is generally assumed to have been too deep for irrigation in antiquity (Cremaschi 1998), and the few archaeological remains that have been discovered upstream of the delta are found not in settlement contexts but in sporadic burial deposits near the town of Takhtabazaar on the Afghan border (Udeumuradov 1993: 71). The topography along the lower course of the river is generally flat, and the entrance to the deltaic fan has been heavily impacted by a series of dams and irrigation works both ancient and modern (Marcolongo and Mozzi 1998; Cerasetti *et al.* 2008b; Cremaschi 1998).



Figure 6. Murghab Delta (LANDSAT 7 Imagery)

1.8.2. Geomorphology and Hydrology

The structure of the modern delta (Figure 7) represents only the latest chapter in a dynamic history, both geomorphological and anthropogenic, and the delta of today is very different than it was during the Bronze Age. Several factors have contributed to these changes. The first is a gradual westward shift of the delta, which Marcolongo and Mozzi (1998) attribute primarily to the slight westward gradient of the underlying geology mentioned above. As a result of this declination, the hydrological system has continuously realigned itself over the past several millennia, and the current delta is situated approximately 40km to the west of its Bronze Age location. A second and possibly related factor is a southward retraction of the delta (Lyapin 1991; Marcolongo and Mozzi 1998). While partially concurrent with the westward shift, the posited reasons for this retraction are different. Rather than a function of the underlying geology, the southward trend has been attributed to water loss resulting from a confluence of environmental and anthropogenic factors. Marcolongo and Mozzi (1998) suggest that aridisation may have contributed to the drying up of the more remote channels, and have

attributed both this process as well as a much earlier recession of the delta to similar climatic variations. Based in part on Ehlers' assessment of water levels in the Caspian Sea (Ehlers 1971), they see the first retraction as having ended by the early fourth millennium, after which a moist period persisted until around 2000 BC, followed by a second period of desiccation and water loss that, in tandem with anthropogenic modifications, has resulted in the delta of today. They associate the Bronze Age occupations with the moist period, in general concurrence with Lyapin's assessment that the extent of the late 3rd millennium delta may be broadly inferred from the Bronze Age settlement pattern (Lyapin 1991). From this period onwards, changes in water management since the Iron Age and possibly earlier have played a role in altering the channel network, a process that likely occurred concurrently with a process of rapidly encroaching desertification towards the middle of the 2nd millennium BC (Cremaschi 1998). This general climatic deterioration, perhaps best documented archaeologically in southwest Asia (e.g. Weiss 1993) and the Levant (e.g. Rosen 2007), has been the subject of significant discussion and need not be revisited here (also see Staubwasser *et al.* 2003 for discussion on oxygen isotope data in south Asia). The implications of these changes for the northern Murghab delta will be further addressed in sections 7.9-7.10.

The changing nature of the Murghab delta has hindered an accurate reconstruction of the ancient hydrological regime, a problem that has been exacerbated by recent urbanism and agricultural development. Fortunately, recent research has begun to address this problem. Employing a combination of satellite imagery, aerial photography and field investigations, researchers associated with the AMMD project have begun to reconstruct the palaeochannel network (Cremaschi 1998; Cerasetti and Mauri 2002). With the assistance of satellite imagery, this research has fostered a deeper understanding of the underlying topography and general hydrological changes. While investigation of the overall infrastructure of the palaeodelta has been extensive, investigation of the specific palaeochannels has been more targeted, and the only published map of these watercourses covers a limited area extending from the limits of the agricultural zone towards the northeastern part of the relict delta (Figure 7). South of this zone, heavy agriculture has obliterated most traces of the pre-modern system of natural channels, although significant research has been devoted to the anthropogenic development of the canal systems (Cerasetti *et al.* 2008b). Largely absent from these hydrological investigations has been any substantial investigation of the northern delta, a situation due both to the restrictive sand cover in the region (see below) as well as the focus of archaeological research agendas elsewhere (A. Ninfo, B. Cerasetti, pers. comm.). An unpublished northern extension to the channel map exists in the AMMD GIS system, although these channels are based almost entirely

on fluvial signatures from aerial photographs rather than field investigation, and discrepancies with the high-resolution satellite imagery suggest that they may only present part of the picture, and at times may be wholly inaccurate (P. Mozzi, pers. comm.; see also section 7.7).

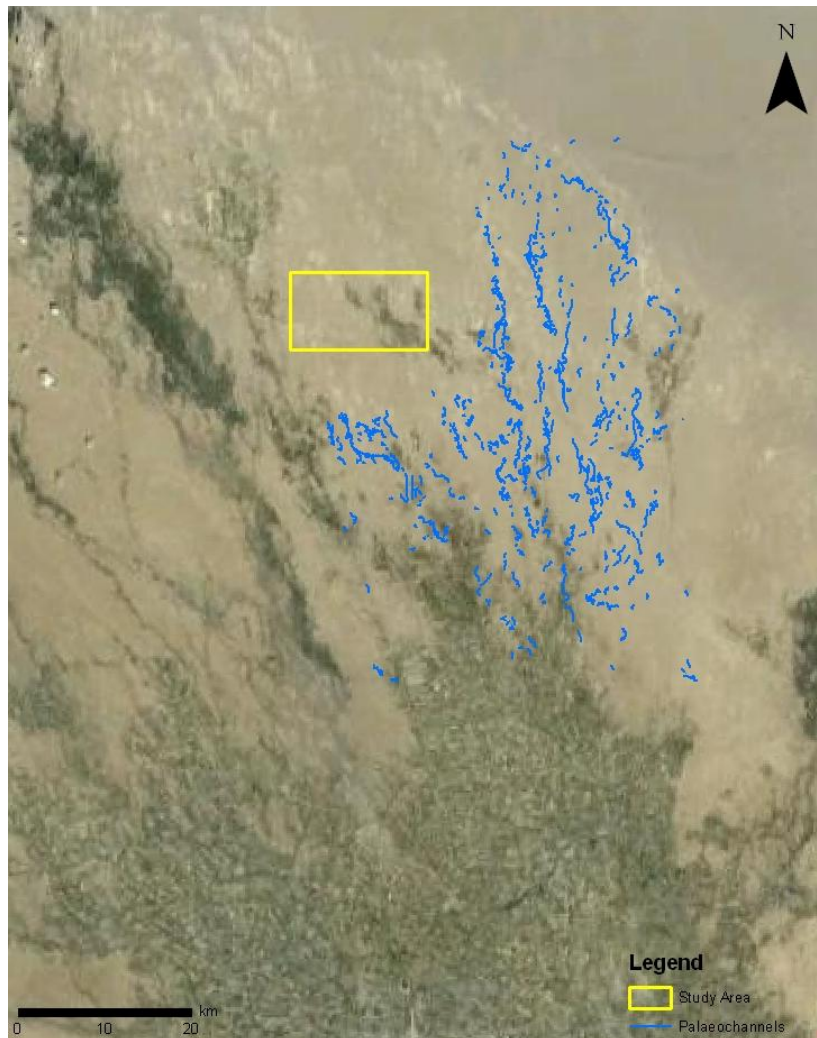


Figure 7. Palaeochannels in the Murghab delta (adapted from vector files in the AMMD GIS system)

1.8.3. Climate and Soils

The deltaic environment represents a distinct ecological zone (Babaev *et al.* 1994). The climate is described by Suslov as a ‘sharply expressed continental climate’ (Suslov 1961: 438) characterised by very hot summers and cold winters. Rainfall in the delta averages only about 100 mm per year, with the vast majority of precipitation occurring during the winter and early spring months. Although year-to-year precipitation may be quite variable, it rarely exceeds

150mm. As a result of the rains, there is a fairly reliable, if variable, flood season that peaks in May (Sala 2007). Due to the arid climate, agriculture is only possible through irrigation, and today cotton and wheat fields are extensive. Although the Karakum Canal is the largest facilitator of the agricultural regime, a network of irrigation canals marks the landscape. These date from various periods, and while new canals are constantly being built, relict canals from the Soviet and earlier periods are common, and natural palaeochannels may also be modified and reused (Marcolongo and Mozzi 1998). Along the main delta channels and the more substantial canals, there is a substantial riverine or *tugai* woodland (Babaev *et al.* 1994), composed largely of tamarisk vegetation, that represents a distinctive micro-environment (Figure 8), and scholars assume that similar woodland would have existed in antiquity (Moore *et al.* 1994, also see section 7.7). Largely as a result of this intensive modern irrigation scheme, groundwater in much of the Murghab delta is relatively shallow. In heavily irrigated regions the depth of the water table is no more than 3m deep, and may be as shallow as a metre or less. In outlying regions of low cultivation, the water table is deeper and may approach 8m (Hiebert 1994a: 6). Due to the heavy irrigation and resulting high water table, soil salinity is high, and evidence of surface salts may be seen throughout the modern delta.



Figure 8. Tugai-type vegetation along an irrigation canal. Upcast from the canal can be seen in the foreground.

Beyond these agricultural zones, the delta landscape is increasingly desolate. Loose sand and loess, largely the result of agricultural activity or other anthropogenic processes such as the construction of roads or canals, is ubiquitous (see Fleskins *et al.* 2007). While large sand dunes are not prevalent in the modern delta, their frequency increases towards the outlying regions of

the palaeodelta, foreshadowing the long, linear barkhan dunes that lay beyond the delta fan. This large, intermediate region may thus be seen as a transitional zone, where sand dunes are intermittent and variable in character. Stable and semi-stable dunes occur in the form of hillocks or ridges and are generally oriented in an N-S or NNW-SSE direction. While not nearly as regular or continuous as the extensive dunes further to the northeast, these features may at times be several metres high and a few dozen metres in breadth. The complexity of the dune landscape thus manifests itself in different forms, sometimes assuming a rolling, gently undulating appearance (Figure 9), while at other times highly variable, punctuated by blow-outs. Vegetation consists largely of haloxylon or black saxaul bushes, and some low grasses (Figure 10). The development of vegetation plays a significant role in the fixation and stabilisation of dunes (Babaev 1973). Active, wind-blown dunes occur as well but these are intermittent, resulting primarily from anthropogenic activity which may intensify soil erosion (Lioubimitseva 2003; Tsvetsinskaya *et al.* 2002).



Figure 9. Landscape of rolling, semi-stable dunes.



Figure 10. Saxaul Vegetation in Autumn and Spring.

Interspersed throughout the delta are hard, cracked clayey surfaces known regionally as takyr (Figure 11).² These are usually small landforms, generally on the order of a few thousand square metres or less, although they may sometimes cover areas of several square kilometres (Orlovsky *et al.* 2004). Takyr usually occur in low-lying regions with respect to the dune ridges and mounds, and are easily discernible on the ground due to their extremely flat, cracked surfaces and conspicuous light colouring. Many scholars broadly associate the exposed takyr with an earlier alluvial surface (e.g. Cattani and Salvatori 2008), although the reality is much more complex and takyr formation can occur in sandy regions where drainage is poor (Fleskins *et al.* 2007). The smooth surface does not support vegetation, and plants only develop when sand is able to accumulate on the takyr surface (Suslov 1961: 457-458). Since sand accumulation may originate from surrounding dunes or from erosion of the takyr surface itself, the takyr-dune boundaries can be fairly complex. In regions of substantial sand cover, the recent wind-blown sand tends to accumulate on the southern slopes of more stable landforms as a result of the deposition of particles resulting from the interaction of wind-blown particles with stable dunes (Lioubimitseva 2003), and the delineation between sand and takyr at the base of these formations is often quite distinct. In many parts of the delta, the takyr are heavily cultivated, resulting in irregularly shaped plough zones determined primarily by the extent of takyr surfaces. This boundary is often defined by loose aeolian deposits, primarily caused by erosion from ploughing and associated activities.



Figure 11. Takyr surface.

The degree to which this modern environment reflects the ancient one is an extremely complex issue and will be explored in more depth in Chapter 2. Scholars generally agree, however, that while the climate may have been slightly wetter during much of the Bronze Age, the agricultural

² Takyr is the Central Asian terminology. Similar desert surfaces are common worldwide, and often referred to as playas, sabkhas, or other terms.

restrictions were likely still those expected in an arid or semi-arid environment (Hiebert 1994a). The precipitation level below which dry-farming becomes unreliable is 200-300mm of rainfall per year (also see Castel 2007; Wilkinson 1994), and Bronze Age rainfall is very unlikely to have exceeded this threshold. As today, agriculture was only possible with irrigation, and the presence of plump six-rowed barley (naked and hulled) and bread wheat attest to a robust irrigation scheme in antiquity (Hiebert 1994a: 134; Miller 1999). Pastoralism was another economic strategy that linked the Bronze Age societies with those of today, and domesticated sheep and goat, and to a lesser extent cattle (Moore 1993; 1994), have long been attested in the Murghab (see Chapter 7). Further opportunities for economic diversity both floral and faunal may have been afforded by the tugai forest as well as the nearby desert environment, and the presence of game including wild boar, tiger, gazelle and birds were available for hunting (see Hiebert 1994a: 131-136 for a detailed discussion on the domestic economy).

1.8.4. Visibility and Archaeological Recovery Potential

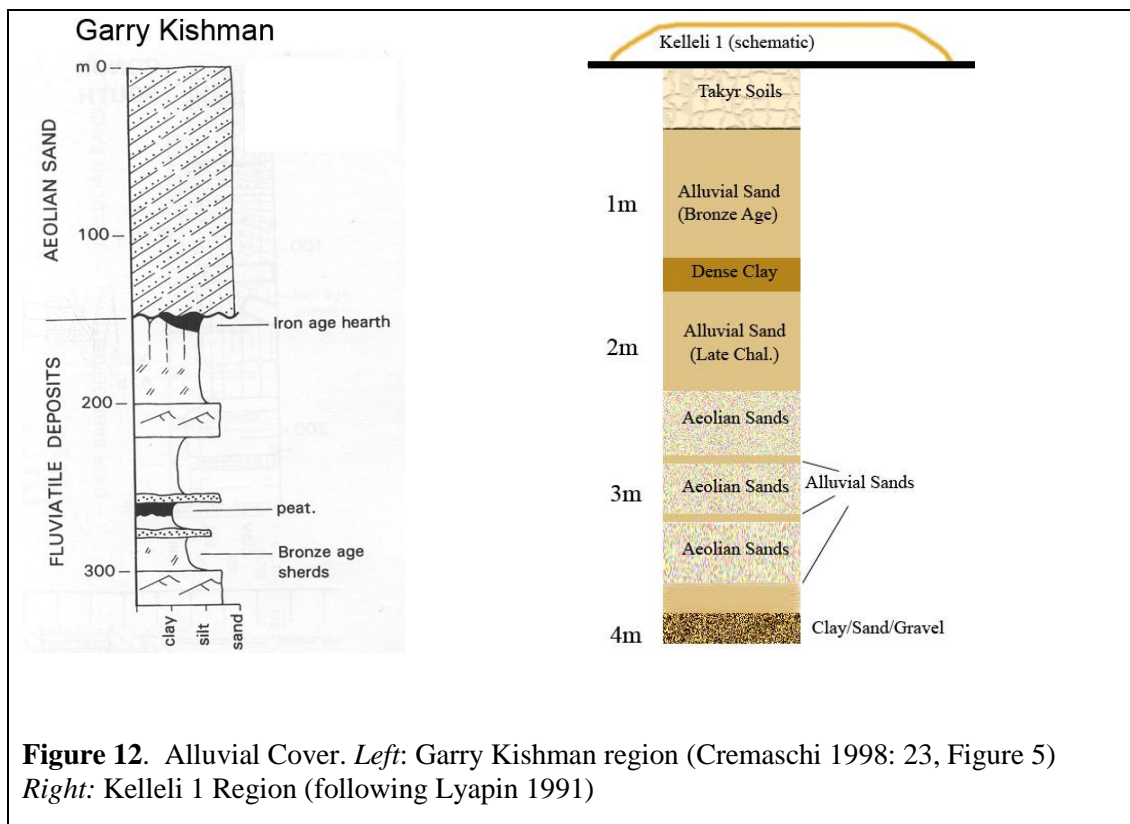
Modern Agriculture

With respect to archaeological recovery, the diverse deltaic landscape presents some significant difficulties. While archaeologists have long recognised that myriad factors may obscure or destroy archaeological sites, the Murghab delta represents an amalgam of such obstructions. Perhaps the most prominent factor contributing to the decreased archaeological visibility is the Karakum Canal. The continued use and development of the canal has spurred an extensive programme of agricultural development, and in conjunction with the urban expansion of the cities of Mary and Bayramaly, many archaeological sites have been damaged or destroyed. One excellent example is Kelleli 1, a large site of about 5 ha in the northern delta that has been completely destroyed by agricultural activity (G. Bonora, pers. comm.).

Alluvial Sedimentation and Site Masking

A second issue is the degree of alluvial deposition. Because of its dynamic geomorphological and hydrological history, alluvial sedimentation in the delta is complex. Researchers generally agree that due to the stability of the Murghab main channel and consequent continuous silting, alluvial deposits in much of the Merv oasis are several metres deep, and potentially an impediment to archaeological recovery (Cattani and Salvatori 2008). In alluvial fans, sediments decrease towards the margin, forming an ‘alluvial wedge’ in which deposition thins out towards the fringe of the fan. This depositional behaviour therefore leads to potentially higher levels of

archaeological recovery on or near the modern land surface towards the fringe of the delta, although Brown has observed that the erosion from more active and braided streams may sometimes destroy or damage small sites (Brown 1997: 38, 279). In the Murghab delta, a similar inverse relationship between alluviation and archaeological visibility has been suggested (Cremaschi 1998), and there are some indications that sites may be more easily detectable in the northern fringe of the delta as a result of the reduced aggradation of alluvial sediments (see below). South of the Takhirbai settlement group, evidence of Bronze Age settlement is almost entirely absent, and only sites from the Iron Age and later are visible, with Salvatori (1998b) suggesting that this may not be due to an actual lack of Bronze Age occupation but to alluvial obstruction. He cites as evidence Cremaschi's (1998) investigations at two sites, AMMD 55 and Garry Kishman, the latter of which is shown in Figure 12. While not located substantially south of Takhirbai, the presence of Bronze Age materials at a depth of 1.5m suggests that the Bronze Age occupational surface may be buried in some areas, although the Bronze Age material at the Takhirbai sites suggests that the alluvial cover is not uniform (Salvatori 2007). Further evidence of the burial of earlier surfaces may be found at the site of Togolok 1. Here, Middle Bronze materials have been recovered from the basal levels of the site, although sherds from this period do not occur on the surface (Hiebert 1994a: 22). While sporadic, there is enough evidence to suggest that many Bronze Age sites may be buried.



Further north, the multitude of Bronze Age sites in the central delta indicates that alluvial deposition is less of an issue. Lyapin (1991) suggests that the appearance of Bronze Age sites on or above takyr surfaces indicates a shallow Bronze Age surface, and posits that a layer of dense clay at a depth of 1.5m may represent the Chalcolithic surface. Moreover, the northern delta is the only area where evidence of early materials prior to the Namazga V period have been recorded. Kohl notes the discovery of Geoksyur-type (Namazga II or III) surface sherds in the Kelleli region, not recorded elsewhere in the delta (Kohl 1984: 146). Moreover, in the basal levels of the now-destroyed site of Kelleli 1, Masimov recorded evidence of carinated greywares that he tentatively associated to the Namazga III-IV periods (Kohl 1984; Masimov 1979). The Kelleli excavations are quite shallow and cultural deposits are usually less than 2m below the raised depe surfaces (Masimov 1979) although Kohl (1984: 146) has cited a total cultural deposit of 3m at Kelleli 1, which offers further evidence that alluvial cover this far north may be shallow enough to reveal traces of pre-Namazga V occupation should it exist. A parallel situation may be seen in the Çarşamba alluvial fan in southern Turkey (Boyer, Roberts & Baird 2006). Here, near-complete site visibility was documented towards the margin of the alluvial cone, a situation researchers attribute to the graduated cessation of alluvial deposition toward the margin of the fan (Figure 13). Although the actual extent of the Bronze Age fluvial activity in the Murghab delta remains unclear, a significant improvement in visibility may be expected in marginal regions here as well.

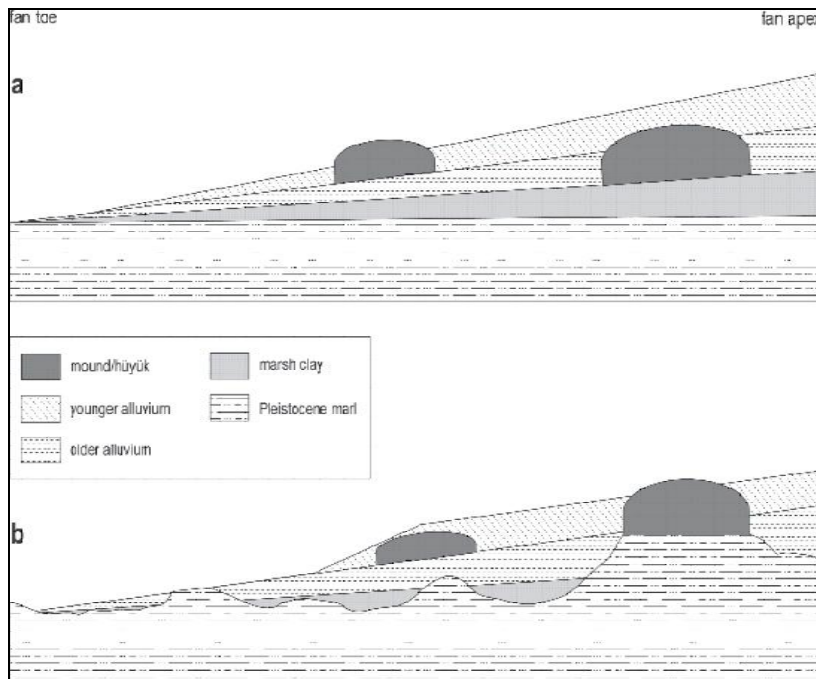


Figure 13. Schematic diagram of the alluvial wedge on the Çarşamba Fan in Turkey and its effect on site visibility (from Boyer et al. 2006: 692, Figure 7).

Dune Cover

An additional factor influencing site recovery only touched upon in this section as it is a central theme of the overall research presented in following chapters is the prevalence of sand dunes. While these may be expected to preserve sites, they pose a significant problem for recovery, since their size completely impedes the detection of archaeological material. Sarianidi has estimated that up to 30% of archaeological sites may simply be invisible due to the presence of substantial dune cover (cited in Kohl 1984: 144). As discussed above, however, sand cover in the delta is not uniform, and much of the prior AMMD research has made use of the windows of opportunity afforded by isolated patches where dune cover is less of an issue. Cattani and Salvatori see the region as a ‘privileged [archaeological] laboratory’ based both on these glimpses of the Bronze Age landscape as well as the high state of preservation of sites, largely due to protection by dune cover (Salvatori 2008b: 60).

1.9. Study Area

1.9.1. Description of Sites and Regional Environment

The specific area of study (Figure 14, Figure 15) comprises a 140 km² zone in the northern portion of the delta located approximately 100 km north of Bayramaly. While remote, the region may be accessed via a paved road from Bayramaly that leads to a large gas compressor station. A major canal parallels this road, leading to an extensive cultivated takyr near the Kelleli site group, and some of the archaeological damage in this area has been noted above. Just south of the gas utility is a smaller dirt road which extends ESE from the main artery. This road parallels a gas pipeline, both of which skirt the site of Egri Bogaz 4 immediately to the north. Despite the heavy agriculture in the Kelleli region, only a small portion of the study area is cultivated and it is in this region that the sites of Egri Bogaz 1, 2 and 3, initially identified by the Soviet expeditions of the 1970s and 1980s (Sarianidi 1990: 5), are located. All three sites have been disturbed to some extent by ploughing, at least in the western sections, although the sites have not been completely destroyed (also see section 5.2.). What is known about these three sites is extremely limited. Udeumuradov conducted 2x2m soundings on the two larger sites, Egri Bogaz 1 and 2, and some of this material has been collected but not analysed. He has also attested the presence of ‘kiln remains’ on these sites, and possible domestic architecture (B. Udeumuradov, pers. comm.).

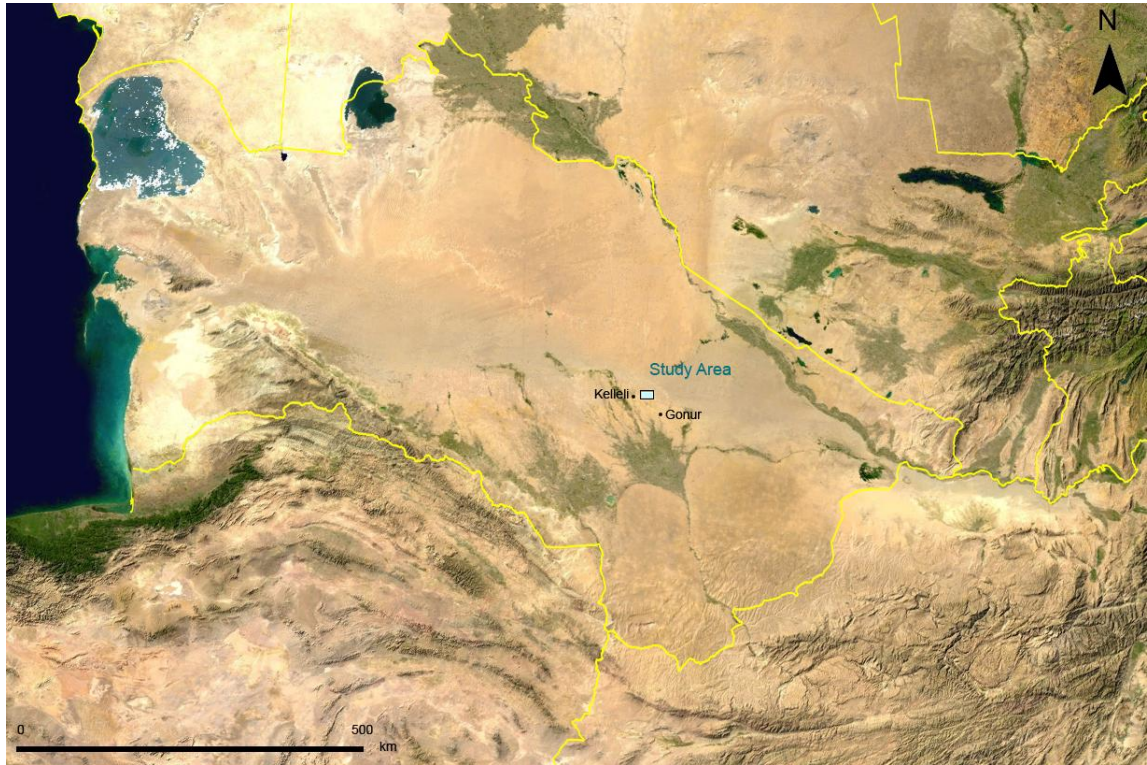


Figure 14. The NMDS study area in its regional context

About 2 km north of this zone, in an area relatively clear of agricultural activity, is the site of Egri Bogaz 4, discovered in the late 1980s. While not subject to the agricultural damage that has affected the other Egri Bogaz sites, it is not completely free of recent activity. The gas pipeline, constructed in the mid-1970s (B. Udeumuradov, pers. comm.), runs about 100m to the north of the road, and both of these cut directly through the broad material scatter associated with Egri Bogaz 4 as several researchers have noted. North of this pipeline is a smaller, older road. This secondary trackway is not always visible in the complex landscape, and is covered in places by heavy dunes. A substantial vegetation cover is present over much of this road, hinting at its age, and it is likely that the road dates from the Soviet period.

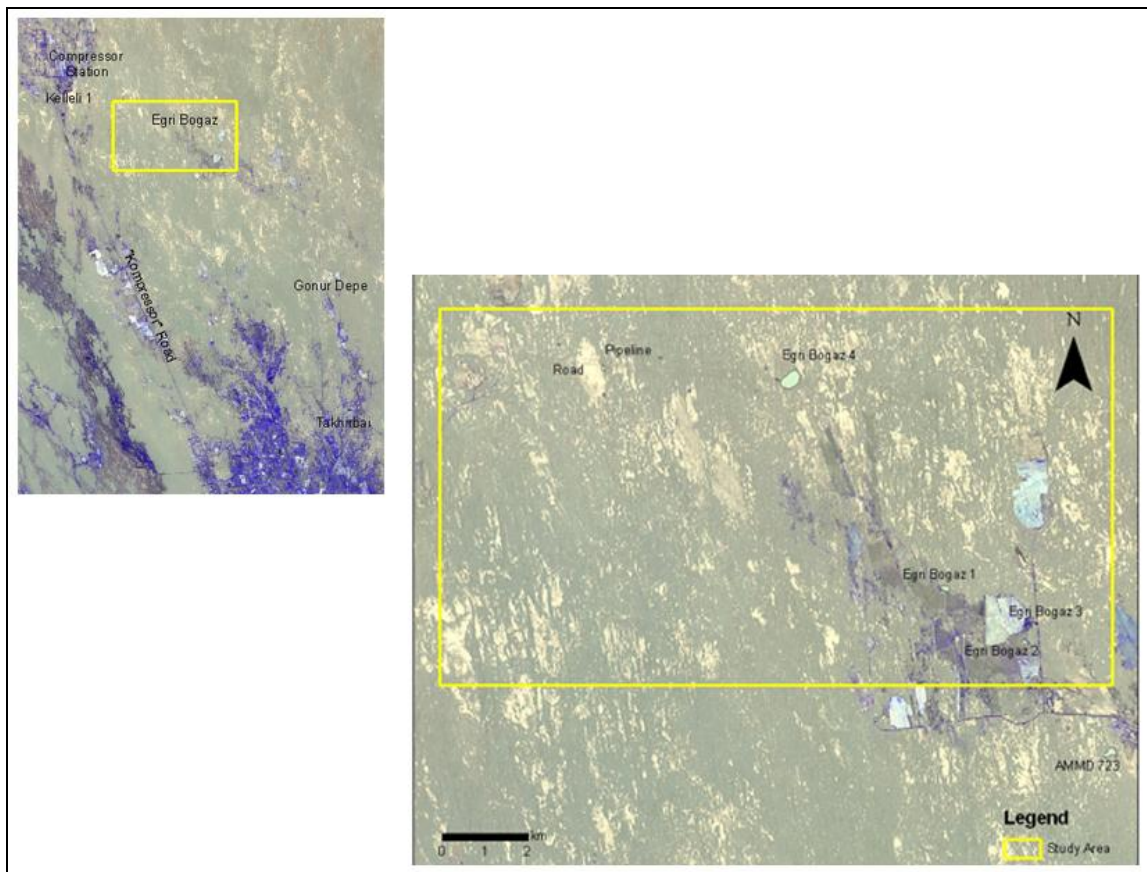


Figure 15: NMDS Study Area (ASTER 3-2-1 False Colour Imagery)

Beyond the presence of a significant surface scatter, almost nothing is known about Egri Bogaz 4. To date, it only appears twice in the published literature, both in publications by the AMMD project, and then only as a site location with minimal supporting information (Bondioli and Tosi 1998: appendices; Cattani and Salvatori 2008: 18-19). Udeumuradov sees the site as yet another small settlement area similar to the other Egri Bogaz settlements and claims to have found ‘kiln remains’ but no evidence of other architecture (B. Udeumuradov, pers. comm.). The substantial surface scatter and the presence of a poorly defined mound have been sufficient to earn Egri Bogaz 4 a designation by the Ministry of Culture as a protected site (see Section 5.5.1.), thereby adding a fourth member to the posited Egri Bogaz settlement group. With the exception of a few transects in the area (Cattani and Salvatori 2008: 18-19), and the collection of some surface material, further research has not been conducted on the site.

1.9.2. The Study Area Within the Context of the Northern Murghab

Due to the lack of research on the Egri Bogaz sites, not a great deal can yet be said about them in their own terms, and it is worthwhile briefly to situate them here in the context of other work conducted in the northern Murghab before examining some of the more theoretical issues in the following chapter. To date, the vast majority of archaeological research in the north has focused on the sites of the Kelleli region (Masimov 1979; Masimov 1980; Masimov and Kohl 1981). Located in the far northwestern portion of the Murghab delta, the settlement group consists of approximately sixteen sites, twelve of which had already been identified by the early 1980s as a result of Masimov's expeditions in the region. Although relatively remote, situated over 40 km from Gonur, and over 10 km from the settlement groups of Taip and Egri Bogaz, the Kelleli complex continues to play a pivotal role in the understanding not only of the northern fringe of the Murghab delta, but of the delta-wide Bronze Age settlement distribution. The majority of work conducted on the Kelleli sites in the 1970s and early 1980s centred on the sites of Kelleli 1, 3, 4 and 6 (Udeumuradov 1993: 13). The cultural horizon of these sites is primarily associated with the Namazga V period (see section 2.4.1), although Udeumuradov has attested Namazga VI materials on Kelleli 6, the only excavated Late Bronze context in the region (Udeumuradov 1993; Hiebert 1994a: 17). Architectural remains are attested on all four of these sites, of which the most substantial is the fortified square structure on Kelleli 3, comprising over a hectare. Probable domestic architecture has been attested on Kelleli 1, 4 and 6, and architecture within the Kelleli 3 wall was considered by Masimov to be domestic in nature (Masimov 1980; Hiebert 1994a: 20)

Work at the Kelleli sites offered the firmest evidence then known of a substantial Namazga V presence in the Murghab delta, and while this period is now known to be well-represented throughout the delta (see section 2.3), its implications were extremely important. Previously, Masson had associated Murghab settlement with the Namazga VI period, which he divided into two phases, an earlier Auchin phase and a later Takhirbai phase (Masson 1988: 91). The Kelleli findings added a layer of complexity to the chronology, and Masimov's findings of an almost identical assemblage between the Kelleli assemblage and that of Altyn Depe in the Namazga V period heavily influenced the chronological understanding of deltaic settlement (Masimov 1979). Unfortunately, while the evidence of Middle Bronze occupation was unquestionable, evidence of prior occupation, well known in the foothills of southern Turkmenistan (Kircho

2004), was scant, represented only by a few painted surface sherds that Masimov has attributed to the Namazga II or III period (Masimov 1980; Hiebert 1994a: 17), as well as occasional ‘carinated greywares’ in the basal levels of Kelleli 1 that he associates with Namazga IV (Masimov 1980). With the exception of a second round of excavations on Kelleli 3 in the mid-1980s, little additional work was conducted in this part of the delta until the surveys of the AMMD in the mid-1990s, noted above. In addition to the identification of a few new sites, these findings also broadened the chronology of both the Kelleli and Egri Bogaz region as Namazga VI materials were identified in surface finds in both regions (Cattani and Salvatori 2008).

Having thus articulated the fledgling state of archaeology in the northern Murghab, the stage is now set to connect some more dots, this time by way of the Egri Bogaz region. As the ninth and most overlooked ‘micro-oasis’—to invoke the conventional classification before deconstructing its meaning—the full incorporation of Egri Bogaz in the known landscape of Murghab occupation is not only warranted, but essential. Its potential to provide information not only on the archaeology of all periods of the Bronze Age, but also on broader issues of survey and interpretation in a different kind of archaeological landscape, offers an enticing environment for research on several fronts. Ultimately, the central thesis is that, through a cautious unification of spatial patterning, scale, and landscape, a much clearer understanding of the northern Murghab settlement landscape has emerged.

Chapter 2. Theoretical Frameworks: Concepts of Survey and Settlement Development in the Murghab Delta

2.1. Central Asian archaeology and state formation

2.1.1. Isolation of Central Asia in Archaeological Research

In order to understand effectively concepts dealing with the surface manifestation of archaeological phenomena and what they mean in relation to the organisation of Murghab societies, it is necessary to gain some perspective by first establishing some theoretical foundations of Central Asian archaeology in general. In a sense, Central Asian archaeology is difficult to define, partially due to the fact that Central Asia itself is so difficult to pin down. Nebulous concepts such as Inner Asia and Middle Asia—terms that may, but do not necessarily, include Afghanistan or Mongolia, are tossed about alongside more historically formal but inconvenient nomenclature such as ‘former Soviet Central Asia’, denoting the five former Soviet states in the region (Sinor 1990). Perhaps it seems odd that such geopolitical semantic games should play a role in archaeology at all. But archaeologists, despite the growing appreciation for the concept of continuum in so many aspects of the field, are still as hard-wired as anyone to appreciate the convenience of distinct classifications and frames of reference.

Andre Gunder Frank, a vocal proponent of rethinking and ultimately elevating the role of Central Asia in our understanding of prehistoric world systems, offers a bleak yet revealing lamentation of the otherwise prevailing interpretation of the region as ‘a black hole in the centre of the world’ (Frank 1992: 1). Frank’s meaning is not so much that the region has been completely ignored—the depth of Central Asia’s archaeological record had become fairly well known by this time, at least in academic circles—but that it has lacked its own frame of reference. Although archaeologists increasingly realise that the concept of a Greater Mesopotamia is too simplistic and insufficient to account for the sheer complexity of the archaeological record throughout Iran and Central Asia, the conceptual centres of gravity continue to focus on southern Mesopotamia and the Indus Valley, and, to a lesser extent, Iran (Kohl 2003).

2.1.2. 'Primary' vs. 'Secondary': The Role of Central Asian Polities in the Broader Cultural Sphere

The idea that the sedentary communities in southern Central Asia were a level below the established civilisations in Mesopotamia and elsewhere in terms of urban complexity is hardly far-fetched. There is a great deal of evidence to suggest that the urban centres in the later 3rd and early 2nd millennium across much of the region did not reach the same stage of development and complexity as did their larger counterparts in Mesopotamia or the Indus Valley. Most sites were small, certainly by the standards of southern Mesopotamia: few sites exceeded 10ha during the Bronze Age, of which the most prominent were Altyn Depe, Ulug Depe and Namazga Depe (Kohl 1984: 107, 117). Another hallmark of many complex societies, a developed writing system (Childe 1950), is also absent, although one need only look to the discussion of whether or not the Indus script constituted a written language to see that the connections between writing and urbanism may not be so clearly defined (Farmer *et al.* 2004; contra Parpola 1986). Drawing in part on these limitations, Masson has suggested that these societies followed a developmental process that he terms 'Anatolian' rather than 'Sumerian' in nature, a dichotomy that he attributes in part to a lack of access to abundant irrigation sources more readily available along the Nile, the Euphrates or the Indus (Masson and Sarianidi 1972: 112).

Inherent in many interpretations of secondary states is the idea that their development was largely driven by external factors, a view that tends to restrict the agency of these communities in charting their own course of development. In Central Asia, urbanism and complexity that developed during the Namazga IV and V periods are treated largely as products of the vibrant trade network spurred by primary centres to the south. Kohl, for example, sees the development of the Central Asian sites as initially resulting from an interregional trade in luxury goods focused on major population centres to the south and west. He attributes these 'punctuated' developmental bursts to responses to external economic shifts rather than internal evolution (Kohl 2003). Similarly, Masson, in further developing his Anatolian interpretation of complexity, treats innovation and technological advance as imported knowledge rather than local advancement (Masson and Sarianidi 1972).

Recent research, however, has criticised this relegation on the grounds that treating smaller communities solely as products of a larger system tends to diminish the local role of these communities (Stein 1999). In upper Mesopotamia, for example, Joan Oates has demonstrated

that urbanisation in the Khabur basin may not have been the direct result of Uruk expansion from southern Mesopotamia, as has been thought. Rather, she attributes the pre-Uruk urban phenomena such as monumental architecture and craft specialisation to local development, possibly spurred in part by access to local obsidian sources (Oates *et al.* 2007; contra Algaze 1989). Gil Stein, in a critique of the core-periphery models that drive archaeological interpretations of 'World Systems' theory (Wallerstein 1974) has noted that 'indigenous polities are no longer seen as the passive victims of unequal exchange relationships in interregional interaction' (Stein 2001: 367). This reassessment of the traditional role of polities not associated with the 'core' has become increasingly applicable to the agricultural societies of Central Asia.

2.2. Trajectories of Urbanism in Southern Turkmenistan

2.2.1. Growth of Urbanism: the Namazga IV and V periods

While these broad scale developmental questions remain outstanding, partially due to the poor understanding of the Early Bronze Age in the region (Kohl 1984: 105), few scholars deny that these societies attained a level of development that either reached or approached urbanism, depending on the interpretation. Indeed, Kohl supports Masson's view of an urban revolution at Altyn Depe, noting that nine of Childe's ten urban criteria, with the exception of writing, were satisfied (Kohl 1984: 126). To the extent that legitimate urbanisation did occur, the current understanding of the process has been drawn largely from developments in the well-studied sites of Altyn Depe and Namazga Depe, seen by Masson as illustrative of the transitions from Namazga IV to Namazga V (1988). Although social complexity is seen to have developed rapidly through the Middle and Late Chalcolithic periods, as evidenced by significant population growth and the development of long-distance trade, the hallmarks of urbanism began to appear most prominently in the second half of the third millennium (Masson and Sarianidi 1972: 112-120). Masson views the proto-urban settlement hierarchy of the Namazga IV period as two-tiered, and distinguishes between small villages and the developing urban centres of Altyn, Namazga and Khapuz Depe, amongst others (Masson and Sarianidi 1972: 118). Although there is strong continuity from Namazga IV to Namazga V in the settlement pattern, several new occupations occur during this period, which Masson (1981) attributes in part to poor agricultural resources in the larger population centres. Evidence of a professional artisan class may be seen in the development of more elaborate kilns and copper smelting furnaces (Masson and Sarianidi 1972: 112). The rapid decline of painted wares towards the end of the Namazga IV period and a

corresponding increase in plain, wheel-made materials may offer further evidence of a shift to mass-produced materials that signify the burgeoning development of specialist classes during the period (Masson and Sarianidi 1972: 112). A related, and possibly contemporary, development may be seen at Ulug Depe, where recent research offers some evidence of the mass-production of figurines of the type found throughout southern Turkmenistan as well as the Murghab (Lecomte 2006). It is tempting to interpret such site-based diversification in production as evidence of a developed, and stratified, administrative entity, although much more research is needed before such a conclusion may be definitively reached.

The Namazga V period is usually associated with the height of urban development in the Kopet Dag foothills, and a time of rapidly developing complexity (Masson and Sarianidi 1972). Hiebert (1994a: 172) observes that, while the Namazga V period exhibits continuity from the preceding period in terms of the settlement pattern, there is a significant shift eastwards towards the Murghab (see discussions in sections 2.3.2. and 7.10). The period also evidences strong signs of a deepening inter-regional outlook, not only in terms of the expansion of settlement, but also in a growing network of trade. Masson suggests that the appearance of imported greywares similar to those found at Hissar reflect increasing contacts with the Iranian plateau, and imported ivory ‘gaming pieces’ as well as the presence of at least one Harappan-type seal indicate contact with the Indus Valley (Masson and Sarianidi 1972: 124).

2.2.2. Decline of the Urban Phase: The Namazga VI Period

The transition from Namazga V to Namazga VI remains poorly understood. Occurring towards the beginning of the second millennium, it has been described as a collapse, or at least a decline, of the urban centres in southern Turkmenistan (Masson 1999). Settlement sizes decreased during this period, with the occupied area of Namazga Depe plummeting from 50ha to 2ha, and the major centre of Altyn Depe was abandoned. Biscione (1977), however, suggests that ‘collapse’ is a misleading term. He disputes any population decline, citing an overall increase in small villages. Perhaps most glaringly, these numbers do not incorporate the burgeoning phenomenon in the Murghab delta—and indeed the development of the BMAC phenomenon has been ascribed directly to this transitional period (see below), the significance of which will be explored in sections 7.6 and 7.9. Salvatori (2008b) has suggested that, similarly, Namazga VI sites in the Murghab were smaller than in the preceding period although more widely distributed.

He attributes the shift primarily to the changing nature of socio-political structures, rather than more deterministic causes related to climate change and overpopulation.

2.3. *Models of Development in the Murghab delta*

2.3.1. Early Occupation in the Delta

With respect to the developing body of knowledge of sedentary societies in Bronze Age Central Asia, the entire Murghab delta remains a grey area largely due to a poor understanding of the origin of settlement in the region. The knowledge of the Central Asian Early Bronze Age is generally poor, and while evidence of the period is firmly established in southern Turkmenistan, it is heavily obstructed by later material (Kohl 1984: 105). In the Murghab delta, solid archaeological evidence that predates the Namazga V period is rare, and with the exception of the few sherds found in the Kelleli region mentioned above, evidence of Early Bronze Age or earlier occupation in Margiana seldom occurs in the published literature. There are, however, occasional hints of early material. Rossi-Osmida believes that an architectural horizon near Adji Kui 1 may date to the late 4th or early 3rd millennium BC, based on the recovery of geometric painted wares as well as two features that he identifies as ovens (G. Rossi-Osmida, pers. comm.) He proposes a similar date for the earliest phase of the neighbouring site of Adji Kui 9 based on C¹⁴ evidence from the cultural horizon, and at least one sample has been confirmed by Salvatori to date to the late fourth millennium (Rossi-Osmida 2007: 72). Salvatori, however, regards this sample as an anomaly with respect to two others of a late third millennium date, which he regards as ‘fully consistent’ with the generally accepted dates for the Namazga V period (Salvatori 2002: 119). Another piece of evidence for early occupation of the delta was the presence of ‘an anthropic level’ at a depth of 9m, consisting of extremely coarse sherds recovered from a natural trench south of Merv in 2007 (Salvatori 2007). The C¹⁴ date on one sample was identified as approximately 5840 BP, offering an indication of a possible Chalcolithic presence in the delta (A. Ninio, pers. comm.).

2.3.2. A Question of Origins: Where did the Murghab Populations Come From?

The Elusive Case for an Indigenous Origin

The lack of solid evidence of occupation prior to the late 3rd millennium in the Murghab has hindered a clear understanding of the origins of settlement in the area, and the result has been a plethora of highly speculative theories regarding the beginnings of the Murghab occupation (P'yankova 1994). In this vein, it is useful to begin with the possibility of an indigenous origin to the Murghab occupation. In the face of an almost complete lack of evidence, support for local origins tends to hinge less on specific theories than on a reluctance to discount completely the possibility that early occupation may have existed in the delta. Considering the several millennia of continuous development a short distance to the west, such a position is reasonable, and two reasons for the lack of evidence are commonly cited. The first is simply a lack of research, invoked by Kohl both in relation to the Murghab as well as the similar absence of the absence of early (pre-Namazga VI) material in Bactria (Kohl, P. in response to Sarianidi and Kohl 1979). He sees the fertile zones in both regions as likely areas for occupation, and observes that the 'lateness of [Bronze Age] discoveries only underscores the cardinal fact that vast, important regions of Western Turkestan have yet to be adequately surveyed for archaeological remains' (Kohl 1984: 143). Lamberg-Karlovsky, as well, cites the enormous research gap from the Murghab through southern Bactria, suggesting that clues may not only be found in the western regions, but possibly in the east towards Quetta and Baluchistan as well (Lamberg-Karlovsky 2003). A second factor, touched upon in section 1.8.4, suggests that the apparent absence of early material is attributable not to lack of settlement but to its undetectability under alluvial deposits. Perhaps the strongest evidence that alluvial deposition is, in fact, a factor is the extent of buried material from the Namazga V period on southern sites such as Togolok 1 (Hiebert 1994a: 22). While this evidence in itself says nothing about earlier (pre-Namazga V) material, the idea that evidence of Chalcolithic or Early Bronze Age material may be more deeply buried further to the south is increasingly thought to be reasonable (Salvatori 2007) and prevents an outright dismissal of the possibility of early settlement in the region.

Each of these extenuating circumstances, however, presents difficulties in fully explaining the lack of evidence of early occupation. The research argument, while certainly valid for regions

both west and east of the Murghab delta where very little work has been done, does not hold up well to scrutiny in the delta itself. In terms of research agendas, the BMAC has been high on the priority list for decades. The fact that substantial material evidence of Chalcolithic or Early Bronze material has almost completely failed to appear in nearly 40 years of research since the discovery of Gonur, not to mention the decades of earlier Soviet work, suggests that while early settlement may have existed, it was likely very limited in comparison to other regions of Turkmenistan, although it is certainly possible that a focus of early settlement may have occurred much further south, fully undetectable beneath the alluvial deposits (section 1.8.4). Indeed, the alluvial argument is somewhat more difficult to challenge since it deals with buried evidence. While alluvial obstruction may serve as a valid explanation in the modern delta, and especially along the main channel of the Murghab, the argument is much less tenable in the north where the potential archaeological visibility is more promising, nearly 100 km from the apex of the delta fan. As noted in section 1.9, the greywares found *in situ* on Kelleli 1, for example were fairly shallow and the thickness of the cultural levels totals no more than 3m, most of which are above ground-level (Kohl 1984: 146). The fact that the sporadic early material in the northern delta is not deeply buried suggests that alluvial obstruction, at least in the north, may not satisfactorily explain the apparent lack of early occupation. Moreover, the absence of material from Namazga IV horizons after decades of excavation, with the notable exception at Kelleli 1, is highly suspect (Masimov 1979). If the material evidence of Namazga V occupation were the result of a continuous indigenous development from the Early Bronze period, it seems logical that evidence for such continuity would at least be detectable in the central delta—even if the alluvial sequence were the cause of obstructed visibility further south. The appearance of Namazga V material immediately above bare soil in Gonur, Togolok, and Adjı Kui 9 indicates that such continuity was probably not the case in much of the delta (Salvatori 2002; Hiebert 1994a: 34). It is, of course, possible that much earlier occupations were succeeded by significant periods of abandonment, but again evidence for such a conclusion remains elusive. If Rossi-Osmida's findings were to be confirmed, they may suggest a more localised presence prior to the Namazga V period in the earliest architectural sequences of Adjı Kui 1, which would certainly strengthen the case for similar finds elsewhere. If such a case were to be proven, it would potentially place the origins of Murghab settlement in a completely different light, and here it is worth reiterating the posited 'first retraction' of the delta mentioned in section 1.8.2. This scenario could suggest that Chalcolithic occupation was present, but confined to a more constrained deltaic system which now eludes detection, buried under millennia of continuous sedimentation. However, even if a Chalcolithic or Early Bronze presence were confirmed, the case for a large-scale occupation prior to the Namazga V period remains tenuous.

External Origins for Murghab Settlement

Mesopotamia

In the absence of strong evidence for early occupation in the delta, most researchers have opted to look elsewhere for its origins. One prominent theory, steadfastly adhered to by Sarianidi in the face of strong recent criticism (see below), places the origins of major Murghab occupation in northern Mesopotamia (Sarianidi 2002a; 2005). This occupation, which he directly links with the BMAC phenomenon, he sees as the direct result of movement from northern Mesopotamia or Iran. While he does not ignore the connections between the Kelleli materials and those found in the Kopet Dag foothills, and has in a correspondence with Salvatori noted the presence of possible Namazga III sherds on Gonur North (S. Salvatori, pers. comm.) he sees this occupation primarily as a failed urban experiment from the west, supplanted with a longer-lived yet still ultimately doomed Namazga VI occupation by way of northern Iran. He cites as evidence certain architectural parallels, such as the ‘courtyards surrounded by corridors’, and ‘complexes of cells’ that he links with sites like Mari and more indirectly to the Aegean, as well as iconographic motifs (Sarianidi 2002b; 2005: 81-85). Indeed, he goes so far as to claim that the architectural tradition is so unique that it ‘could not have had its roots in Central Asia’ (Sarianidi 2002a: 86), although such a claim seems misplaced given the visual similarities between the Gonur North architecture and that of the broadly contemporary site of Kelleli 3, particularly the external bastions (Figure 16). Rossi-Osmida sees a direct Mesopotamian connection as well, although in a somewhat modified form. Based largely on what he perceives as the military-type character of the fortified architecture, as well as the evidence of a horse ‘bridles’ he postulates an Akkadian phase in the Murghab, possibly associated with a mercantile colony or military expansion (see discussion in Rossi-Osmida 2007: 124-132). His assessment has been sharply criticised by Salvatori, who finds no solid evidence to support Rossi-Osmida’s interpretation, although Salvatori does acknowledge that merchants from Mesopotamia *could* have been present in the region (Salvatori 2007).

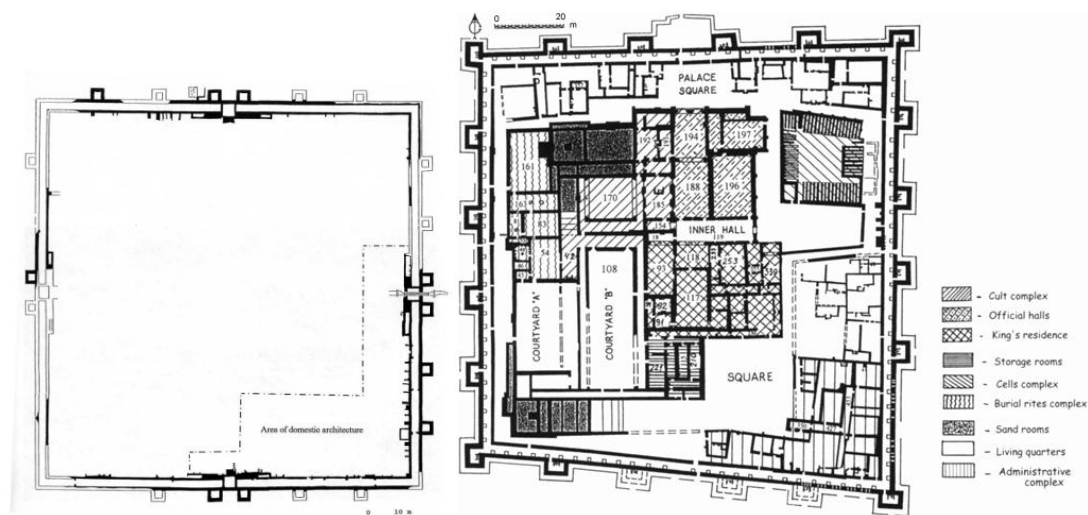


Figure 16. Comparison of fortified architecture in the Murghab delta. Kelleli 3 is shown on the left, and the ‘palace’ of Gonur North on the right.

These theories of direct migration to explain the Murghab phenomenon have been roundly questioned by Lamberg-Karlovsky (1994; 2003). While he concedes that cultural and iconographic parallels existed across western Asia in the late 3rd and early 2nd millennium, he views these as natural by-products of cultural interaction and association rather than direct signatures of a migrating or invading population. Moreover, Sarianidi sees the BMAC as a new phenomenon associated with the Namazga VI period. Such a position essentially discounts the cultural continuity from the Namazga V period, a view largely contradicted by the material continuity on Gonur North (Hiebert 1994a). Udeumuradov, as well, envisions a primarily indigenous development through the Bronze Age, noting the continuity of ceramic styles from the earliest known delta occupation (Udeumuradov 1993).

Kopet Dag

Although Sarianidi continues to stand his ground, most theorists now suggest that the origins of Murghab settlement were less exotic. The prevailing school of thought, supported by scholars such as Masson, holds that the similarities in the late Namazga V horizons at Altyn Depe and the early levels at the Kelleli sites are clear (Masson 1988: 92; Masimov 1980). In addition to similarities in standard ceramic forms, similar iconographic and symbolic trajectories are also seen to link the two regions. One such link may be found in the violin-shaped figurines common to the Namazga V period in southern Turkmen sites (Figure 17), approximately duplicated in the

Murghab.³ Since this material is the earliest (with the exceptions noted above) to be found in the delta, it suggests to these scholars an eastward shift of populations from the Kopet Dag to the Murghab (Masson 1988; Hiebert 1994b). This view is supported by Biscione (1977), who sees developments in the Murghab as broadly contemporaneous with a reorientation, rather than a decline, of the settlement structure in the Kopet Dag. He suggests an eastward shift in occupational focus from the piedmont of southern Turkmenistan to the Murghab delta, as evidenced by the decline of the large sites of Altyn Depe and Namazga Depe and corresponding increase in small village settlements. It must be stressed, however, that Biscione's assessment came in the 1970s, towards the beginning of significant exploration of the Murghab when the significant Namazga V occupation was not yet known, so contemporaneous occupation of both regions may have been overlooked. Moreover, subsequent investigations in the 1980s and 1990s revealed the broad expanse of Namazga V settlement in the Murghab, suggesting some degree of contemporaneity with the urban phase in Southern Turkmenistan (Udeumuradov 1993). It is also worth stressing that little work has been done in the regions between the Tedjen and Murghab deltas, an area that, were settlement to be found, could certainly shed more light on the Namazga V transition in both regions.



Figure 17. Namazga V figurines from Altyn Depe (Kohl 1984: plate 11c)

Additional Theories

While the predominant theories therefore involve movement from the west, a few other possibilities have been put forward. Kohl has expressed scepticism that migration alone is the sole explanatory factor for Murghab presence, and has suggested that the peopling of the

³Some stylistic differences occur—the common braided hairstyles found at Altyn Depe have not been located in the Murghab sites, although impressions of such figurines have been located in Kelleli (Kohl 1984)

Murghab may have arisen in part from the sedentarisation and incorporation of 'less developed' groups in the region' (Kohl 1984: 150; 2002). Kohl bases his argument in part on the supposition that overall populations in the Murghab were much greater than in southern Turkmenistan during this time, a possibility that, in his view, weakens the case for a primarily migratory origin. However, the argument for the sedentarisation of steppe groups is unconvincing for this period due to their late appearance in the Murghab, and the arrival of these peoples only began in earnest towards the end of the Bronze Age (Cattani *et al.* 2008b; c). However, it is interesting to note the results of several physical-anthropological investigations conducted in the Gonur North cemetery that suggest that the Gonur population may not all originate from the same region (Dubova 2006). While the subject is quite controversial and not a part of the mainstream discourse in the region, it is interesting in light of Kohl's hypothesis. However, given the fledgling state of research, such theories must remain largely speculative. A second interpretation holds that the western regions may in fact not be the centre of origin at all, and that Murghab societies may derive from the Baluchistan region (Lamberg-Karlovsky 2003). This hypothesis is based on similarities in material culture over a wide region in the fourth and third millennia, exhibited in part in the geometric motifs in Quetta ware during the Namazga II period, as well as a vast trading network of lapis lazuli, stone vessels, and probably tin, to indicate that cultural contacts were clearly in place across a vast expanse of territory by the early 3rd millennium.

While the concept of migration as the sole cause of culture change or development is often seen as antiquated and simplistic (Trigger 2006:310), and while Kohl may be correct in questioning whether it is the only factor, it must be included as one of the plausible factors concerning settlement development in the Murghab. There are obvious links between the Kopet Dag and the Murghab delta during the late Namazga V period, and the contemporaneity of the changing settlement pattern in the Kopet Dag and the rise of Murghab occupations is accepted by most scholars, as discussed above. If evidence of late Chalcolithic and Early Bronze occupation remains elusive, it would continue to weaken the case for indigenous occupation and further support the possibility that the Murghab populations originated elsewhere. Further support may be drawn from the comparatively late occupation of the Bactrian sites of the BMAC, associated with Namazga VI occupation (Askarov 1973). New excavations at Tilla Bulak in southern Uzbekistan confirm earlier research at Sapallitepa that place these sites at the earliest phase of the Late Bronze Age (Kaniuth 2007b). The lack of a significant Namazga V presence in northern Bactria, like that of Namazga IV in the Murghab, may indicate an eastward shift of the focus of settlement from an initial occupation in the Kopet Dag (see discussion in section 7.10).

2.4. *Structure of the Murghab Societies*

In the absence of a well-established model for the Murghab delta, and amid conflicting interpretations of the degree of ‘urbanism’ or ‘statehood’ that characterised the Bronze Age societies in the region, archaeologists have often been forced to rely on borrowed interpretations from better-established models elsewhere. We have already seen how both Masson and Kohl have transferred Childe’s interpretations to the complex settlement of Altyn Depe. The reapplication of these in the Murghab, especially given the apparently similar level of complexity of Gonur, is therefore unsurprising. As a result, established interpretations of settlement hierarchies and structures drawn largely from Mesopotamian research have often been applied rather arbitrarily. Masimov (1981), for example, envisions a three-tiered hierarchy where the smallest sites are below 5ha, second-tier sites comprise 5-10ha and the largest constitute regional centres and are larger than 10ha. Gonur is treated as a special case, and Kohl (1984: 147) suggests it may represent the ‘principal political centre’ of the entire region based on its large size and the wealth of its material. P’yankova and Masson propose a two-tiered model, suggesting that the main distinction lies between fortified and unfortified settlements (P’yankova 1994; Masson and Sarianidi 1972: 112). The primacy of settlements within each region remains unclear, and its interpretation tends to vary with the researcher. Sarianidi treats Gonur as the ‘capital’ of the entire ‘Margush’ society (Sarianidi 2005: 74), and considers the other fortified sites to be the capitals of their respective ‘micro-oasis’ (see below). The definition of these secondary centres, however, is not always clear and in some cases, as with Egri Bogaz 1 or Kelleli 1, they seem to derive not from the presence of monumental architecture but from site size. In other cases, more than one walled ‘citadel’ occurs within each region. For example, Sarianidi sees Adjı Kui 8 as the pre-eminent settlement of the Adjı Kui settlement group (Sarianidi 1990: 7-8). While it may be the largest settlement in terms of the size of the mound, substantial evidence of major occupations occur elsewhere in the area. On Adjı Kui 9, a fortified, parallelogram-shaped ‘citadel’ comprises much of its associated settlement mound. Only about 500m away is the site of Adjı Kui 1, where architectural evidence is extensive. Moreover, the recent discovery of what appears to be a multi-roomed ceramic production area on Adjı Kui 1, as evidenced by at least two large kilns as well as a significant quantity of fired brick, clearly warrants a re-examination of the nature of centrality and administration in the central Murghab (G. Rossi-Osmida, pers. comm.).

2.4.1. The Traditional Oasis Model

Traditional, yet still prevalent, interpretations of the Murghab have treated the late 3rd and early 2nd millennium occupation of the delta as an ‘oasis civilisation’ (Hiebert 1994a; Sarianidi 1990). While still invoked by many researchers, the term masks several shades of meaning at different analytical levels. At the broadest level, the oasis concept pertains to the anomalous presence, in the middle of a desert, of a fertile landscape within which human settlement and agriculture were possible (Hiebert 1994a: 6). The potential for state development in regions of restricted water access has been a lively theoretical discussion for decades. Early notions of a direct causal link between irrigation and administrative complexity advocated by scholars such as Wittfogel (1957) were, in a sense, inverted by Adams’ more symbiotic model in which irrigation projects developed as a function of increasing administrative complexity (1965). Newer interpretations place more emphasis on the ways in which individuals and communities chose to respond to adverse conditions such as flooding or changing fluvial patterns, as well as the ways in which they may have perceived such potential dangers (Brown 1997).

While the nature of such ‘hydraulic societies’ (Wittfogel 1957) is extremely important with respect to large scale questions concerning the development of complexity in regions where water is scarce, the oasis concept has been invoked at another level in the context of Murghab settlement. At this level, most scholars see the settlement structure as comprised of a series of distinct ‘micro-oases’ (Hiebert 1994a: 39), that is, restricted micro-environments within which settlement was possible. This model derives largely from a prevailing interpretation of the Karakum Desert as an essentially timeless entity, a hostile environment of wind-deposited sands that has existed throughout the Holocene (Gerasimov and Brice 1978). This static interpretation of the landscape has fostered a fairly deterministic view of settlement potential from a geomorphological perspective, one that restricts the Bronze Age communities to individual oases with sufficient access to water and fertile land. ‘Each cluster of archaeological sites’, according to Cremaschi, ‘was thought to represent a single oasis fed by a branch of the Murghab river’ (Cremaschi 1998: 15). In this view, settlements were ultimately bound to their micro-environments within which small-scale irrigation would have been practised. The origin of these hypothetical micro-environments has not been adequately addressed, and while they seem to be taken for granted by Sarianidi (2005: 35) and Kohl (1984: 146), Moore stresses the human component in developing such micro-environments. She posits a ‘human-modified micro-climate’ for Gonur, which may be similarly applied to other settlement groups throughout the delta (Moore *et al.* 1994). In each of these interpretations, however, agricultural potential seems

to be largely limited by the landscape. Beyond the limits of these agricultural fields lay a presumptive hostile and infertile desert, and Hiebert uses the oasis model to propose a mixed economic environment where sheep and goat, sustained by desert grasses and saxaul vegetation, would have been herded just beyond the local agricultural fields (Moore *et al.* 1994; Hiebert 1994a: 136, Figure 8.2). Hiebert further suggests that dunes may have restricted movement and interaction, enabling communication and trade only along specific corridors.

The Oasis Model: Chronological Scheme and Settlement 'Shift'

Inherent in the standard 'oasis model' are two major assumptions. The first is the contemporaneity of sites within each micro-oasis. Within each settlement group, sites are seen to exist over a fairly short chronological span. Small sites, even some with 'citadels' like Kelleli 3, are almost invariably treated as single period entities (Kohl 1984: 150), an assumption drawn primarily from the shallow depth of cultural material on most of these sites. The thicker cultural levels and complex stratigraphy on several of the larger sites may indicate a longer duration of occupation, and although individual 'citadels' are often seen to represent a single building phase, Sarianidi acknowledges at least three architectural stages for the palace at Gonur North although he relegates the entire site to the Namazga VI period, and Rossi-Osmida has observed complex architectural sequences at both Adjı Kui 1 and 9 (Rossi-Osmida 2004; 2007: 70-71). It should be noted, however, that his architectural schemes represent a general chronological progression and appears to overlook more complex building sequences within the main structure as indicated by extremely complex stratigraphy that remains unaddressed in the published literature (Figure 18).



Figure 18. Stratigraphy on Adjı Kui 1

The second hallmark of the oasis model is a three-phase chronological scheme, associated with a posited occupational shift to the south that most Soviet and Central Asian researchers attributed to the drying up and retraction of the delta channels (e.g. Sarianidi and Kohl 1981). Originally, this scheme was fairly straightforward due to the proposed simultaneous occupation within each micro-oasis (Figure 19). The first phase, linked with the late Namazga V period, encompasses the Kelleli sites and is restricted to the northern delta. The second phase is associated with the development of the BMAC and linked with settlement groups in the central delta including Gonur and Adji Kui. The final phase is located even further south, comprised primarily of the sites in the Togolok and Takhirbai group (Kohl 1984: 143). It is this period that several archaeologists have linked with the influx of the 'Andronovo' groups from the northern steppes, as evidenced by the presence of incised coarsewares in conjunction with several sites of the period, primarily in domestic contexts (Hiebert *et al.* 2002; Cattani *et al.* 2008c). While the three-phase scheme has largely been retained, the sites within each group have shifted with a deepening understanding of the chronological complexity in the region. According to Hiebert, a deep sounding conducted on the Gonur North mound revealed 2 distinct phases (Hiebert 1994a: 30-38). The lowest, Phase 1, he associates with Kelleli-type materials, while Phase 2, associated with the BMAC, shows parallels with the southern mound of Gonur and the Togolok sites. The third phase, found on the south but not the north mound of Gonur, is linked with the last period of the Bronze Age and corresponds with the Takhirbai 3 assemblage. It is interesting to note that Hiebert dates the monumental architecture of Gonur North to Phase 1, predating the BMAC phase, and the implications of this chronology will be explored further in section 7.6.

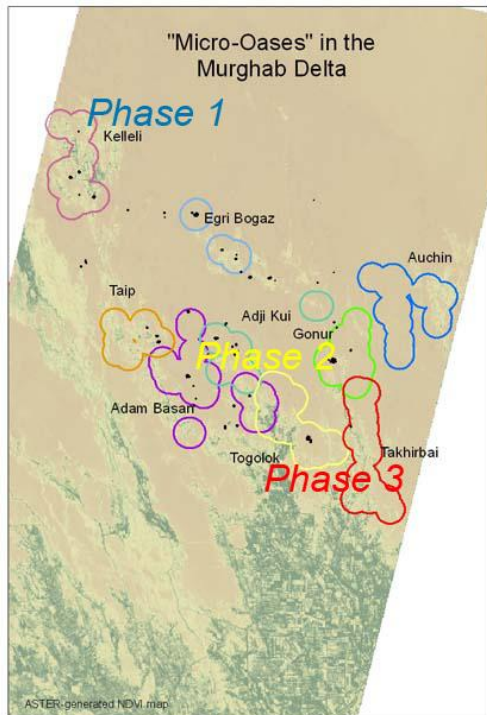


Figure 19. ‘Micro-Oases’ in the Murghab delta. *Phase 1:* Kelleli Phase (Namazga V) *Phase 2:* Gonur Phase (Namazga VI) *Phase 3:* Togolok/Takhirbai Phase (late Namazga VI)

The Oasis Model: Problems and Refinements

Prior to the AMMD research, discussed in detail below, no significant challenges to the general concept of an oasis civilisation had been made. There have been, however, more nuanced interpretations, primarily with respect to the issues of chronology and settlement shift. As early as 1984, Kohl voiced scepticism that ‘only the terminal waters of the Murghab in the Kelleli oasis would have been occupied during the initial colonisation or settling of the Murghab’ (Kohl 1984: 146). The implication was that additional material from the period probably existed but had not been discovered—a situation that has since changed dramatically with the identification of ‘Kelleli phase’ materials in basal levels of Gonur North, Togolok 1, and Adji Kui 9 (Hiebert 1994a: 22; Salvatori 2002; also see chronological assessment of Rossi-Osmida 2007, noted above). Just as Namazga V materials have now been found throughout the delta, Namazga VI materials have been found to co-occur with early sites, even as far north as Kelleli (Hiebert 1994a: 17; Cattani and Salvatori 2008). Both circumstances greatly weaken the case for the direct association between location and chronology.

As the chronological interpretation grows more complex, the related concept of a direct settlement shift from northwest to southeast must be questioned as well. The chronological links between Kelleli and Gonur North, as well as the deeply buried materials from the same period at Togolok and perhaps further south (Cremaschi 1998) offer evidence that the both Middle and Late Bronze Age occupation in the delta was widespread. While the majority of new settlements during the Late Bronze Age appear to occur further south, as evidenced by the proliferation of Namazga VI materials in this region in the early second millennium BC, it is not until the middle of the 2nd millennium BC that a clearly discernible southward regression in settlement begins, and this change becomes fully clear by the Iron Age. Such widespread, and apparently concurrent, occupation throughout the Bronze Age has called into serious question the idea of a simple three-phase settlement shift moving southwards in conjunction with the retraction of the delta. While it is certainly the case that the scope of *visible* Middle Bronze settlement, as observed from Namazga V surface materials, generally extends further north than Late Bronze material, this is probably partially attributable to visibility issues. In terms of an actual geographic shift, the lack of late-period sites in the north as well as the appearance of many Late Bronze sites in the central delta and Takhirbai-period sites in the southern delta indicate a retraction of the settlement pattern rather than an outright shift, with fewer new foundations occurring in the north.

2.4.2. Rethinking the Oasis Model: The AMMD model of a Continuous Alluvial Plain

Few archaeologists, however, have questioned the basic idea of the ‘oasis civilisation’ (for one example see Renfrew 2006), although recently that has begun to change. Currently, and somewhat quietly, the core underpinnings of the ‘oasis civilisation’ are undergoing a significant theoretical re-examination. While the notion of the ‘oasis civilisation’ persists, the recent AMMD research has begun to provide a very different picture of the landscape. According to new interpretations, desertification began in earnest millennia later than previously thought. In a direct challenge to Gerasimov’s static interpretation of the Karakum (see above), Cremaschi (1998) suggests that desertification may not have actually occurred until much later, and proposes a mid-2nd millennium date for the onset of the process. A detailed analysis of the geomorphological data is beyond the scope of the current study (see Marcolongo and Mozzi 1998; Lyapin 1991; Cremaschi 1998), but two main pieces of evidence must be addressed. One is the ‘exclusive’ presence of aeolian sands in the ‘looters’ pits’ of the Gonur North cemetery

(1998: 18). Cremaschi asserts that the natural stratigraphy of these graves consists of alluvial layers, so the presence of wind-deposited sand in the pits indicates a later onset of desert encroachment that post-dates the digging of the graves. The second piece of evidence that Cremaschi cites for late desertification are the results of a series of long-range transects conducted in the mid 1990s which linked several major Bronze Age sites (Figure 20). The purpose of these transects was to test the degree to which settlement was actually restricted to the purported micro-oases, or whether the pattern was more complex. Contrary to the earlier interpretations, the survey revealed evidence of pottery, and in some cases 'sites', along all transects surveyed (Cattani and Salvatori 2008). According to Cattani and Salvatori, the findings indicate that material is continuous throughout the delta and not localised as per the earlier models. The implication, they claim, is that the Murghab phenomenon should not be viewed from the perspective of isolated, desert-enclosed micro-oases along a few available channels, but in terms of an open well-watered floodplain where settlement and irrigation agriculture were common. While either case would certainly have required access to reliable water sources, especially in this arid region, this new model effectively removes the landscape of desert dunes as an impediment to settlement and agriculture (Cattani & Salvatori 2008). Moreover, the model allows for a more integrated settlement system where occupation and agriculture could thus be much more widespread (see below). Although intensive studies of off-site distributions have been limited, a number of suggestions have been put forth regarding the interpretation of this continuous distribution of material. Drawing on Wilkinson's work in northern Mesopotamia (Wilkinson 1982; 1994; Wilkinson and Tucker 1995), several researchers associated with the AMMD project have attributed the broad distributions of low-density material to manuring processes, although these possibilities have not been explored in detail (see Section 7.4). A study of 'off-site' material near the sites of Togolok and Site 55, conducted by Serge Cleuziou demonstrated spikes in sherd densities several hundred metres away from the extremely high-density areas (2000+ sherds/100m²) that he associates with the main settlement areas (Cleuziou *et al.* 1998). The largest of these purported off-site distributions—peaks in an otherwise low-density distribution—he attributes to farms or villages, although he notes the tendency of material to gather in small over-sanded depressions as well, often resulting in potential 'false positives' caused by more recent geomorphological processes rather than legitimate reflections of the ancient settlement pattern.

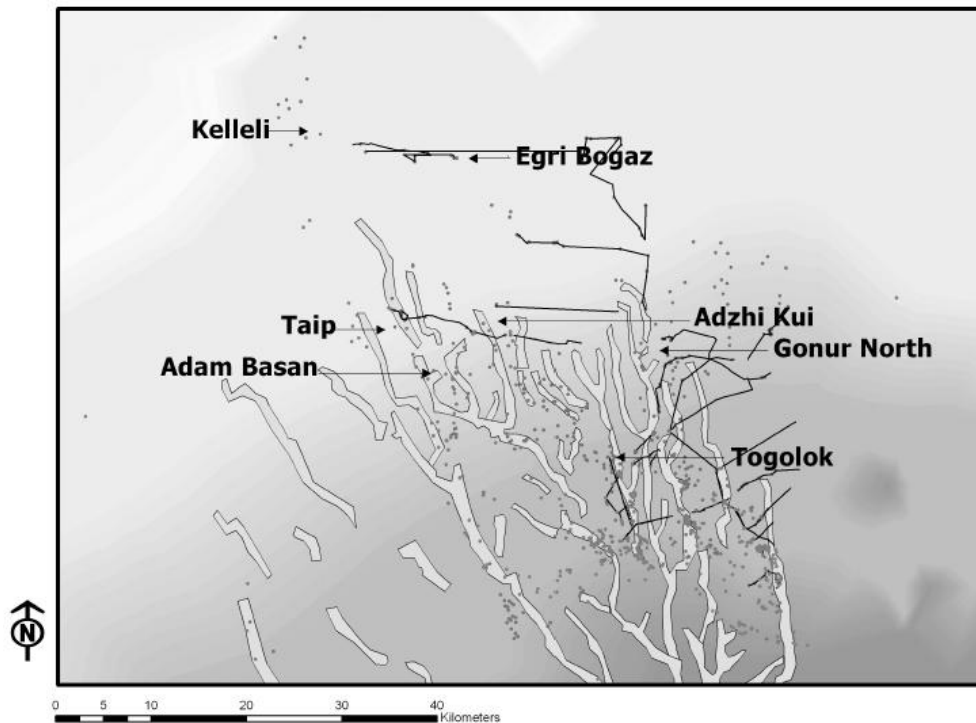


Figure 20. Long-range transects conducted by AMMD researchers: 1995-2005 (from Cattani and Salvatori 2008: 4, Figure 1.1) (reprinted with permission)

2.4.3. Interpretations of socio-political dynamics

As a result of this work, AMMD researchers have proposed new models of proto-urban structure for the delta. In their view, the delta at the end of the 3rd millennium BC was as-yet unhindered by aeolian encroachment. They therefore largely discount the possibility of an inhospitable and barren desert environment as a primary determinant of the settlement structure, instead viewing the Murghab settlement system as an integrated entity with an organisation determined by ‘rules relative to group organisation dynamics’ rather than environmental determinants (Salvatori 2008b: 62). Structurally, they envision a well-structured three-tiered settlement hierarchy, with Gonur as the most prominent and central site (but see discussion in Section 7.6). Via a Thiessen polygon model, among other approaches, of how the socio-political landscape might have been subdivided, they suggest that major settlements were evenly distributed throughout the delta (Salvatori 2008b: 7,62), although they do not elaborate on the nature of the interactions between settlements or the way in which such a polity or polities may have functioned. During the Late Bronze Age, sites decreased in size but increased substantially in number, possibly the result of what Salvatori sees as an institutional ‘crisis’ (Salvatori 2008b: 66). He envisions this period as socially fragmented, where even the largest sites comprised only a few hectares. The posited

socio-political deterioration intensified into the end of the Bronze Age, when increasing desertification spurred the development of the more restrictive micro-oasis character, largely in place by the Iron Age. While the AMMD researchers acknowledge desertification as a part of this process, they do not see it as the primary explanatory factor; the changes are again attributed primarily to social and political dynamics with environmental change as a secondary cause (Salvatori 2008b). It should be noted that part of the basis for this Late Bronze model stems from the lack of an identifiable ‘capital’ during the Late Bronze Age analogous to the role of Gonur North in the preceding period (Salvatori 1998a). It is quite possible that issues of restricted visibility in the delta have simply obscured such a site, or simply that not enough work has been done to identify the primary site of the period (Salvatori 1998). While it is much too early at this stage of Murghab research to propose a possible Late Bronze ‘capital’, some of the recent finds at Adjı Kui 1, which Salvatori (2002) associates with the Namazga VI period, are worth noting. Here, Rossi-Osmida has recently uncovered two large, well-preserved two-chambered kilns, which appear to be associated with the mass-production of fired bricks, several of which have been found in the same section of the site (G. Rossi-Osmida, pers. comm.). These kilns may be structurally similar to an enormous kiln in the Gonur North palace (Sarianidi 2002a), albeit much smaller, and may offer some evidence of a similar mode of large-scale production and distribution taking place in the central delta, concurrent with or post-dating the abandonment of Gonur North. Moreover, the discovery during the current research of a large, 3 ha mound with heavy and distinctive surface material, as well as similar distributions several hundred metres away, indicates that the extent of occupation even in the Adjı Kui region has to date been underestimated, and may offer much more information about the Late Bronze Age in the Murghab (see description in section 4.5.3).

2.4.4. Critique of the AMMD Model

Since projects associated with the AMMD comprise the bulk of ongoing Bronze Age research in the delta, the findings of which have only recently been published in full, there has been little chance for the archaeological community to evaluate the new interpretations. To date, the only researcher who has addressed the new model directly is Rossi, who questions whether or not it actually offers a substantially different interpretation from the older oasis-based interpretations (Rossi-Osmida 2007: 16-18; see Salvatori 2007 for response). Rossi-Osmida questions the originality of the AMMD model, suggesting that the retention of Gonur as a primary site and continued inclusion of Sarianidi's provincial capitals as secondary sites does not offer a

significant modification of Sarianidi's original interpretation. While there is some validity to this criticism, Rossi-Osmida fails to address adequately the implication of the significantly different geomorphological model just described, which represents a substantial departure from traditional interpretations. Without addressing this aspect, he neglects the potential implications that settlement in an oasis versus settlement in a floodplain may entail. Perhaps inadvertently, his critique also calls attention to another, more pervasive problem with Murghab research: the dichotomous perception of desert versus floodplain. Such a black-and-white interpretation of what was clearly a complex geomorphological and archaeological region risks masking the actual complexities of both environment and settlement, an issue which will be explored more fully in sections 7.7-7.9.

2.5. Hydrology and Settlement in the Murghab

Central to an accurate interpretation of the settlement structure is an understanding of the geomorphological underpinnings of the delta, particularly with respect to water. The importance of linking archaeological evidence with geomorphology and hydrology has been well established elsewhere (e.g. Wells *et al.* 2001), both in terms of the potential ramifications of modern landscape change and surface remains, as well as the relationship between actual occupation and the contemporary morphology of the landscape. One example in the Central Asian region may be seen in the Sarykymish basin, located about 100 km southwest of where the Amu Darya empties into the Aral Sea (Tsvetsinskaya *et al.* 2002). Research here has provided one of the few glimpses into the relationship between settlement takyr development, drawing a link between the abandonment of medieval irrigation systems and the development of the takyr surface. It should be noted, however, that the geomorphology in this region is significantly different than that of the Murghab. With respect to the Murghab itself, the focus of geoarchaeological research has been largely to gain a clearer understanding of the palaeochannels with respect to broad-scale settlement patterns and irrigation practices (Cremaschi 1998). Although the early identification of palaeochannels rested largely on chance discovery rather than intensive geomorphological research of the palaeodelta, the generally linear orientation of sites suggested an alignment of sites that corresponded to the available river channels. Lyapin (1991), for example, has essentially extrapolated the presence of channels from the archaeological sites. The AMMD research has deepened this association, employing a combination of archaeological survey, remote sensing data, and geomorphological research, to

gain a clearer understanding of the diachronic changes of the river system (Cerasetti *et al.* 2008b).

The basic trajectory of the hydrological changes, presented in Figure 21, has been discussed at length by Cerasetti (2008b), of which a brief review is presented here. The work conducted by the AMMD shows that, for the duration of the Bronze Age and into the early Iron Age, the delta channels appear to have remained relatively stable, especially in the western part of the delta. Changes in the hydrology during these periods are attributed primarily to the environmental and geomorphological factors described in section 1.8 rather than human modification of the channels (2008a). In subsequent periods, however, anthropogenic modification of the delta probably played a much larger role from the mid-late Iron Age into the Achaemenid period. Cerasetti (2008a) suggests that the significant transformation most likely began in the early Iron Age, with the foundation of the large site of Yaz Depe. The growth of the Yaz population and subsequent foundation of Erk Kala towards the end of the Iron Age represented growing, centralised polities that required, in the face of declining water resources, a more centralised management of large irrigation systems (Cerasetti *et al.* 2008a: 37). It is in this period that the first dams were constructed just south of Merv. Ultimately, in this view, the retraction of the delta channels resulted mainly from the large-scale management and diversion of water. While Cerasetti thus attributes the late Iron Age transformation of the delta primarily to these large-scale irrigation projects and dams, it is reasonable to assume that the increasingly adverse climatic and geomorphological conditions that developed towards the end of the Bronze Age would have continued. If this is the case, then it may make more sense to view the settlement contraction during the Iron Age and Achaemenid periods as the result of a confluence of factors both environmental and anthropogenic. In such a scenario, it may be that the decrease in available riverine resources during the Bronze Age, largely driven by environmental deterioration at first, accelerated towards the end of the second millennium and ultimately spurred both the need for and the possibility of a centralised management of a dwindling primary resource. While such a possibility may call to mind Wittfogel's deterministic models of 'oriental', 'despotic' states driven by dwindling water access, we cannot discount the role of increasing desertification in the development of the later settlement structure.

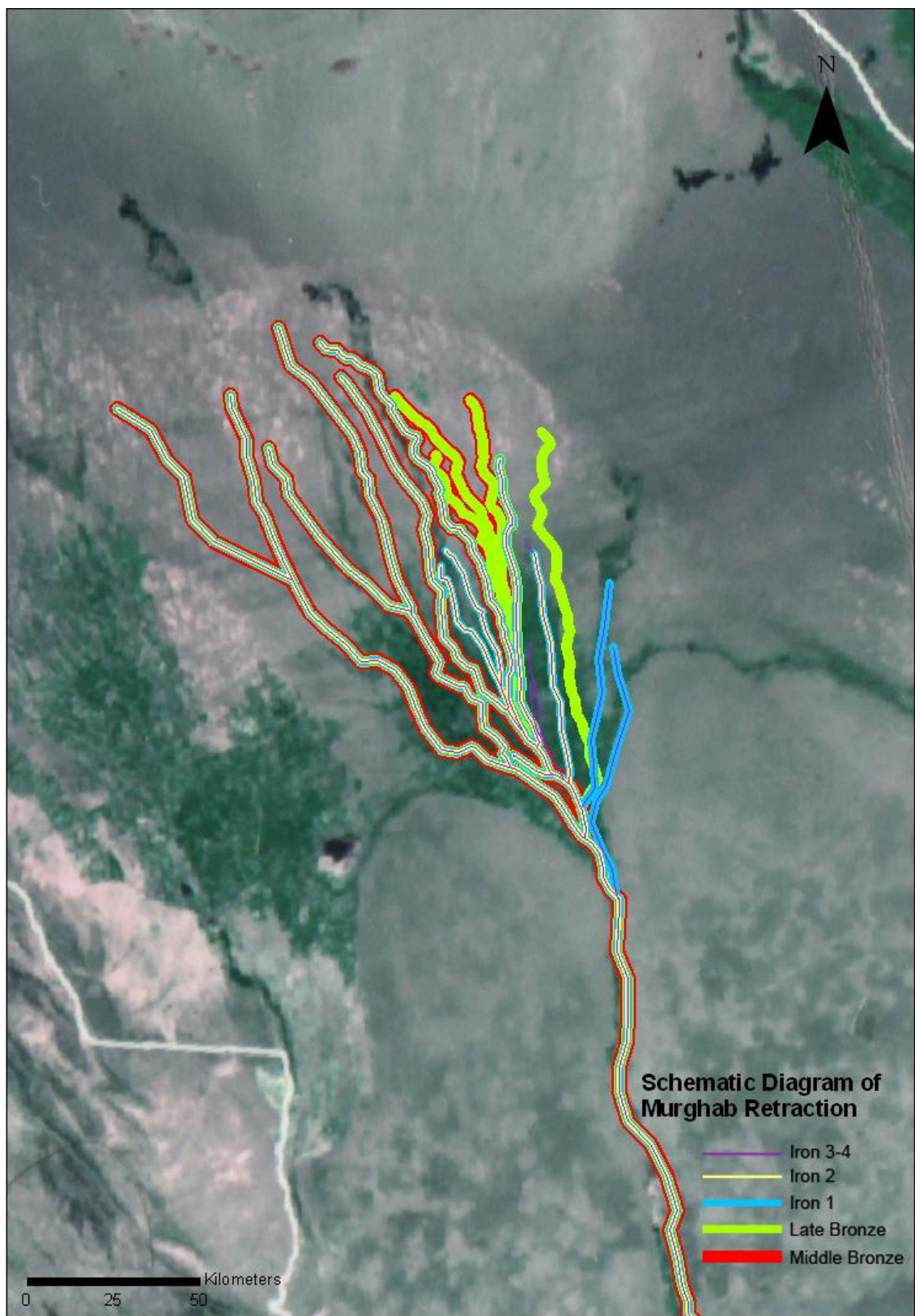


Figure 21. Schematic diagram of Murghab fluvial system. Adapted from AMMD GIS data. Colours represent periods of channel activity. Note the persistence of the western channels into the Iron Age, while active channels decline elsewhere after the Late Bronze Age.

2.6. *Theories of Archaeological Survey*

The importance of examining settlement patterns with respect to the landscapes in which they occur has long been recognised in archaeology, and this priority is often addressed through archaeological survey (Banning 2002). Contrary to the micro-scale of excavations—although these too may offer a wealth of information about ancient landscapes through stratigraphic analysis—the large land areas covered by surveys offer a glimpse into a region as a whole. The manner in which such a large-scale tool has been employed, however, has changed greatly over the decades. Initially, survey was largely seen as a precursor to the ‘main attraction’ of excavation (Ammerman 1981: 63). Although Braidwood, among others, recognised the importance of understanding sites in their environmental context as early as the 1930s (Wilkinson 2000), the primary function of surveys was to target sites for future research. The development of archaeological survey as a study in itself began to come to the forefront in the 1960s, with a growing focus on settlement pattern analysis, pioneered by Willey a decade earlier. ‘All-inclusive settlement pattern study,’ Willey reflected, ‘was an attempt to prepare a groundwork for an archaeological reconstruction that would approximate a total society, not just the elite segment of that society’ (Willey 1989: 170). Vogt (1956) outlined three thematic constructs underlying this integrated study as follows:

‘one which explores the relationships of living arrangements to geographical features, such as topography, soils, vegetation types, or rainfall zones; a second which focuses upon the social structural inferences that can be made about socio-political and ceremonial organization; and a third which concentrates upon the study of change through time with a view to providing materials for generalizing about cultural processes.’ (Vogt 1956)

Such questions sought largely to understand settlement patterns within a wider anthropological context (Holdaway and Fanning 2008), and methods inspired by work in Mesoamerica heavily influenced survey in the Near East in the 1960s (Parsons 1972: 4). Adams’ groundbreaking work in the Diyala valley (1965), which investigated the relationships between diachronic settlement change and shifting alluvial environments, employed settlement pattern analysis to elucidate the relationships between settlement, hydrology and irrigation, an integrated approach which remains highly influential today. Advances in geological and geomorphological research have greatly informed many of these more recent projects, and Wells (2001) asserts that, without properly integrating archaeological survey with these fields, a full comprehension of socio-

economic structures must remain elusive. In Central Asia, recent projects often employing integrated teams of Russian, Central Asian and Western researchers have begun to focus more heavily on understanding settlement landscapes, and in addition to the incorporation of more developed geomorphological and hydrological studies, newer technologies such as GIS and remote sensing have facilitated many of these projects (Mantellini *et al.* 2008; Cerasetti *et al.* 2008b).

An inherent assumption of archaeological survey is that the visible distribution of surface material represents, to some extent, the original settlement landscape (Taylor *et al.* 2000). While it is often tempting to assume a fairly faithful representation, and in formal terms an accurate correlation of the manifestation of past archaeological landscapes with the present-day surface distribution, such a logical leap is very problematic. One issue concerns the displacement of surface material. Potsherds change their position in the ground over time, undergoing processes of fragmentation and redeposition. Although recent studies (e.g. Taylor *et al.* 2000) have suggested that certain processes such as ploughing may not significantly alter the general distribution of surface scatters, factors such as erosion, fragmentation, human or animal disturbance—all of these may significantly alter the original location of material in the landscape. Another major issue is recovery bias, which encompasses several factors influencing the ability to accurately record the actual distribution of sites in an archaeological landscape. Van Leusen has identified three general categories of bias: conceptual, visual and observer (for discussion see Van Leusen 2002: 4-6). To these we may introduce a fourth, accessibility bias, which may reflect the primacy of certain potential survey areas at the expense of others based on the difficulty in reaching parts of the landscape. Of these biases, observer bias is, perhaps, the least pertinent to most Murghab research. Given the enormous geographical scope of the previous Murghab surveys, any perceptual differences that may vary from archaeologist to archaeologist are probably far less of a factor than the large-scale effects of limited visibility and accessibility of large swathes of the landscape. Of greater significance are conceptual and visibility biases which are addressed in some detail below.

Perhaps the best-known example of conceptual bias may be seen in what Wilkinson refers to as the ‘tyranny of the tell’, the tendency for archaeologists to focus on large sites either because of their visual prominence or perceived archaeological potential (Wilkinson 2003a: 100). An excellent example of such large-site dominance may be seen in recent work conducted in the ‘Amuq Valley in southern Turkey, designed in part to revisit Braidwood’s survey in the 1930s which revealed a preponderance of large, nucleated Bronze Age tells (Yener *et al.* 2000;

Wilkinson *et al.* 2005; Casana 2003). The ‘Amuq Valley survey, as well as similar work in northern Syria revealed hundreds of previously unrecorded sites, among them dispersed towns and villages from the later periods that went undetected in the original survey. The new findings offered a new interpretation of diachronic settlement change that had previously eluded detection. Recent research in the Orontes valley, as well, has been designed to further the understanding of flat or ploughed-out sites, often detectable through high resolution satellite imagery or aerial photographs (Philip 2002). The under-representation of small sites is by no means confined to the Near East, however. Glassow (1985) has criticised the secondary research status of small sites in coastal California, noting that they offer new classes of archaeological information that may not be available on more significant settlements, and Talmage and Chesler (1977) have discussed the importance of small sites in understanding a broader range of issues including resource procurement, socio-political structures, and questions of culture contact and demographics. In the Murghab, the focus on large sites has been pervasive; the recording of smaller occupations, especially during the Soviet surveys, was generally the by-product of chance discovery. Fortunately, the importance of small sites has been increasingly recognised in Central Asian survey, driven in part by a growing focus on sedentary-nomadic interactions in the Murghab delta (e.g. Cattani *et al.* 2008b) as well as in recent projects in Samarkand (e.g. Stride *et al.* 2009), and hundreds of small, flat sites have been recorded as a result (Bondioli and Tosi 1998). Unfortunately, the new focus on small nomadic sites in the Murghab continues to deflect focus from smaller sedentary occupations which, passed over by the shifting focus of new research agendas, remain poorly understood.

While these forms of conceptual bias tend to reflect the research aims and methodologies of the archaeologists involved, visibility bias deals with the fact that not all archaeological sites can be detected in various landscapes. Several factors, discussed extensively in the archaeological literature, may be responsible for the masking of archaeological sites (Brown 1997; Wilkinson and Tucker 1995: 17). Anthropogenic factors for example, such as urban development and agricultural activity, may cover, alter, or destroy a site. Such factors are, of course, not limited to modern human activity—large scale reoccupations of sites in antiquity may mask any evidence of earlier activity—thus introducing a chronological skew to the original settlement patterns. In addition to human activity, geomorphological factors play an enormous role in determining whether or not sites are detectable. In alluvial environments, long known to be prime locations for human settlement due to the fertility of soils and access to water for drinking and irrigation, sites are often, paradoxically, more difficult to locate. Shifting river patterns and the constant accumulation of alluvial sediments create a serious problem in terms of site masking

(Brown 1997: 38,42). While large sites are often prominent enough to be detected above the alluvium, small settlements may be completely lost beneath dozens of metres of deposition. In arid environments, shifting aeolian deposits may completely cover sites that were recently visible—or in some cases reveal long-hidden sites from under the sands. In this context, it is worth addressing these processes in the context of fluvial avulsion. Channel shifts are an issue of particular significance in the examination of southern Mesopotamian settlement patterns and, given the comparable arid environment and relatively flat alluvial environment in the Murghab, Researchers such as Adams (1965, 1981) and Morozova (2005) have explored the aggradation of fluvial sediments and irrigation soils in regions where channels rise above the flood plain. The resulting development of natural levees (Adams 1965: 9-11), while fertile and favourable for agricultural development, may also mask earlier deposits. Conversely, avulsion or desiccation of river channels can facilitate the development of dunes that may completely obscure archaeological sites (Morozova 2005).

Even in regions where archaeological material is visible, a plethora of post-depositional factors may create a significant, and in some cases possibly an irreconcilable, mismatch between the visible archaeological record and the actual nature of the settlement patterns in antiquity (Suenson-Taylor 1999). Erosional and deflationary processes, while perhaps not completely effacing the surface evidence of a settlement, may result in a host of post-depositional complications. Aeolian deflation may strip a site of fine material and redeposit it elsewhere, creating a skewed interpretation of the original surface distribution. Deflation, especially in arid environments, may also result in the conflation of several distinct periods through the removal of fine sediments, thus complicating accurate assessments of site size and chronologies (Rick 2002).

Although visibility bias is a well-recognised problem, and usually acknowledged in some form, attempts to systematically measure its effects have been few, and the results somewhat inconclusive. Shennan, through a regression analysis of various factors affecting visibility, has found that while the primary land cover was the most significant contributor to site obstruction, light bias was also a factor in the specific case of Romano-British pottery (Shennan 1985: 39, Table 4.5). These factors may be expected to change in different landscapes however, so local factors must be taken into account when considering potential effects of visibility on site recovery. Unfortunately, systematic attempts to correct for visibility bias have been largely unsuccessful, although a few attempts have been made (Bevan and Conolly 2004: 127; Mattingly *et al.* 2000). Boeotian surveys have employed a simple visibility index—an

assessment of visibility on a 1-10 scale used to modify detected sherd counts (Bintliff and Snodgrass 1988). A similar model has been tested by Bevan and Conolly (2004), although they observe that the resulting corrected counts are highly suspect and likely not representative of the original archaeological landscape. Ideal corrective models, if they are feasible at all, may require more robust methods of standardising our assessment of differential visibility, although little research has been done in this particular area. Some potential may be seen in the CARS scale of standardised visibility, although this has not been effectively applied to archaeology (Van Leusen 2002: 4-12).

2.7. What is a 'Site'?

Given the magnitude of these biases, it is necessary to revisit a fundamental question of archaeological survey: What can be learned from such an uncertainly founded reconstruction of a settlement landscape? Surface distributions cannot simply be projected back in time as a means of reconstructing the original distribution of communities. Present-day scatters of sherds and other artefacts are the products of complex and dynamic processes, ancient as well as modern. Even as early as the beginning of the last century, Stein (1921: 93) recognised the complex nature of pottery distributions in the landscape around Khotan and elsewhere in the Tarim Basin. While attributing many of the primary pottery distributions to *tatis*, 'the wind-eroded ground of ancient occupation', he also recognised the continuous distribution of material throughout the landscape, which he associated with cultivation in antiquity. Because of the complexity of depositional and post-depositional processes, the identification and interpretation of spatial patterns of perceived settlements can offer only a shadowy representation of the original landscape of habitation. This very loose correlation between present-day surface distributions and actual occupation raises many interpretative questions. One is the pervasive concept of 'site' as the basic unit of analysis. In the vast majority of surveys, whether the goals are to target future excavations, to understand settlement in relation to its surroundings, or some other research focus, the basic analytical units are the archaeological sites—the atoms in a molecular structure of discrete, yet somehow interlinked, archaeological entities. Depending on the nature of the survey, as well as the previous knowledge of the archaeological environment, this discrete unit may be a mound, a scatter of potsherds or lithics, or any other entity or combination of entities. However, the actual nature of human occupation is complex, and by reducing settlements to simple points on a map we risk overlooking important qualitative data (Dunnell and Dancey 1983; Plog *et al.* 1978; Laurenza *et al.* 2005).

The question of what actually constitutes an archaeological site is a complex one for several reasons. One theoretical issue addresses the fact that the activities and movements of populations are not necessarily restricted by boundaries—either abstract or real. Activity areas—whether social, agricultural or otherwise—commonly take place beyond a confined habitation space. More central to the current research, however, is the identification of the site with respect to collection and recovery methods—the ways in which ‘sites’ are identified, or perhaps passed over, in archaeological survey. Plog has provided a definition of site as a ‘discrete and potentially interpretable locus of material...spatially bounded with those boundaries marked by at least relative changes in artefact density.’ (Plog *et al.* 1978: 390) Gallant offers a somewhat modified definition that accounts for variations in visibility, defining a site as an area of significant departure from the regional patterning where visibility is *not* an attenuating factor (Gallant 1986). While such models are theoretically useful, the leap from concept to methodology is notoriously difficult since the line between occupational scatter and background distribution is typically a matter of gradual rather than substantial change. Site identification, then, often depends on some kind of threshold above which material may be classified as a site. In some cases, this may be determined simply by the presence or absence of cultural material, sometimes in conjunction with a more qualitative perception of the nature of the distribution. More often, sites are assessed based on sherd counts, or diagnostic totals, although these may vary widely across surveys. Although such methods have been criticised as simplistic and overly deterministic (Plog *et al.* 1978), they can offer a level of formality that may be lacking in more qualitative or less systematic assessments (Gallant 1986).

2.8. Spatial Patterning in Survey Interpretation

The assignment of these definable locations within a survey area, typically sites but possibly sampling areas, landscape features, or other entities, allows archaeologists to work with a set of punctuated ‘known values’, nodes through which some assessment of spatial relationships may be derived. The ways in which the leap from discrete units to settlement patterns is conducted are manifold, and Banning has identified several commonly-used conceptual models that highlight the changing interpretations of settlement patterns (Banning 2002: 13-22). The somewhat simplistic monument-based approach of many early surveys, as a result of an increasing awareness of the complexity of not only sites but also distributions of material throughout archaeological landscapes, has given way to a number of complex models that

attempt to address not only settlement location, but variability both on and off-site as well. The manner in which these spatial relationships are conceptualised significantly influences the interpretation of human settlement and interaction. For example, the development of catchment analysis in the 1970s employed spatial relationships as a way of exploring the potential economic influence of sites based on resource accessibility (e.g. Vita Finzi and Higgs 1970). By contrast, the juxtaposition of survey and spatial relationships in the Americas focused largely on political and social interactions (Holdaway and Fanning 2008). In many regions, the developing processual school during the period fostered the incorporation of spatial models such as Thiessen polygons to assess relative dominance of individual sites (e.g. Conrad 1978), although such methods have come under criticism on the grounds that they are spatially deterministic and fail to take into account 'a myriad of other social and cultural factors' that may influence inter-site dynamics (Conolly and Lake 2006: 212). Another commonly used method of understanding settlement relationships is rank-size distribution, or Zipf's law (Laxton and Cavanagh 1995). Several researchers have examined rank-size in relation to diachronic settlement shifts, often with respect to settlement nucleation and dispersal, or processes of urbanisation or ruralisation (e.g. Wilkinson and Tucker 1995). In the Murghab, both methods have been deployed in conjunction with hydrological and geomorphological data to determine diachronic changes in the settlement structure (Salvatori 1998a; 2008b). It is worth stressing, however, that the effectiveness of such spatial approaches is largely contingent on broadly reliable and repeatable measurements of site size or material distribution, a condition that, as will be shown in later chapters, cannot always be satisfied in the Murghab delta.

Recent research has attempted to delve more deeply into the settlement landscape by focusing more heavily on systemic interactions and off-site activities (Mattingly *et al.* 2000; Wilkinson and Tucker 1995). Rather than simply examining points against a landscape, these studies have focused heavily on the material distribution itself. Nonetheless, the concept of 'site' is usually retained, and can prove useful both conceptually and administratively (Bevan and Conolly 2004; Dunnell and Dancey 1983: 272). This difficulty in identifying the actual location of occupation, in conjunction with the growing understanding that settlement patterns are not just point-based but act as continua at varying degrees, has led to a plethora of systematic approaches to examining the settlement landscape as whole, beyond simply settlements in a landscape. Building on Dunnell and Dancy's concept of the siteless survey, Ebert (1992) has explored the concept of 'distributional archaeology', designed to address the full distribution of artefacts in a landscape. He invokes the concept of continuum in order to move away from the more common

site/non-site dichotomy, on the grounds that such a duality is too simplistic to understand the intermediate level distributions that may not clearly fall into either category.

2.9. The Role of Scale

Another theoretical aspect of archaeological survey, and indeed of archaeological interpretation more generally, is scale. Although many archaeological projects implicitly recognise this concept to some extent, direct investigations of scale are often skirted in archaeological research. This is perhaps not surprising given the nebulous and highly subjective character of scale as a concept, referring as it does to a notion far more complex than simply a set of analytical windows. The very act of determining the scale of a project establishes a spatial judgement, a fixed aspect to what in reality was a continuous phenomenon (Atkinson 2000). Moreover, even if we accept that it may not be possible to examine all pertinent scales at once, a further problem exists in that the analytical scales chosen by archaeologists may not match the actual experience of the people they study. It is beyond the scope of this work to explore in detail the theoretical implications of such a disconnect—but it is worth noting that what archaeologists identify as a town, or a community, or any other discrete locus of habitation may not have been perceived as such by its inhabitants; and the implications for interpreting correctly the social, political or economic aspects of a past society may be profound.

In the discourse on archaeological survey, discussion of scale usually focuses on the spatial aspect. Sanders envisioned a two-tiered scale, differentiating between ‘community settlement patterns’ that dealt primarily with on-site distribution of local architecture, public works, and community structure, and ‘zonal settlement patterns’, which focused on the spatial and ‘symbiotic relationships between communities’ (Sanders 1956). This macro versus micro interpretation of archaeological landscapes has remained highly pervasive and the merits of ‘extensive’ versus ‘intensive’ survey remain a poignant theoretical topic (Caraher *et al.* 2006). Although researchers recognised early on that effective surveys need not—and should not—operate at only one scale of analysis (Adams 1965), such a dichotomy remains pervasive, and the discourse among advocates of macro- and micro-scale survey remains contentious (Wilkinson 2000; 2003b; Caraher *et al.* 2006). One of the primary issues is the degree to which surveys conducted at one scale can address questions of another scale. Such a problem has been articulated by Kowalewski (2008), who cautions that extremely intensive field surveys are often inadequate to address broader-scale social, political and economic questions. While he does not

singularly dismiss the value of such projects, he suggests that they would be more effective as ‘follow-up studies after regional coverage’ (2008: 250). Such a conclusion is supported by Matthews and Glatz (2009) who, in an assessment of the utility of intensive survey in refining local data in the Paphlagonia region in Anatolia, do not see a substantial interpretative benefit of intensive survey alone when applied to regional investigations. Similar concerns have been voiced by Blanton (2001) who, in a critical review of the Mediterranean surveys that comprise the POPULUS project, objects to the ‘myopic’ attention paid to local settlement landscapes at the expense of regional analysis; and cautions against regional level interpretations derived solely from localised study. He goes so far as to suggest that these kinds of projects, due in part to methodological differences as well as their tendency to disregard broader theoretical interpretations, may actually hinder rather than foster comparative study.

This dichotomy of regional versus local in the archaeological discourse has resulted in a kind of pitched battle in which it is not always easy to detect a middle ground. However, human settlement and interaction are not confined to any single analytical scale, and it is in this respect that intermediate scales of analysis must be addressed. To better understand such a concept it may be useful to turn to Kantner who, in an excellent discussion of the hazy concept of regions in archaeology, offers a definition of these as ‘spaces for which meaningful relationships can be defined between past human behaviour, the material signatures people left behind, and/or the varied and dynamic physical and social contexts in which human activity occurred’ (Kantner 2008: 41). Although not speaking directly to archaeological survey, this definition is highly applicable to the kinds of inter-site interactions that settlement pattern analysis seeks to address. Moreover, his definition is useful in its suggestion that regional studies are, in essence, about interaction. What it does not—and perhaps cannot—address are the actual dimensions of such an analysis, and the exploration of this ambiguity is potentially extremely useful in the study of archaeological survey.

How, then, can these intermediate scales be explored? A relatively new approach in archaeology concerns multi-scalar analysis, essentially the investigation of more than one spatial scale at the same time, or at least as part of an integrated strategy. Such analysis offers the ability to re-scale data as well as the model used to represent that data, ultimately offering the chance to narrow or broaden the scope of analysis and modify research questions accordingly (Atkinson 2000). Ideally, however, a general understanding of the dataset is required in order to determine such scales, and this inherent assumption is rarely satisfied in archaeology due to the paucity of available data. For example, an archaeologist investigating a cluster of artefacts would be hard-

pressed to determine whether the size of the cluster represents the ideal analytical scale, or whether to enlarge the window to consider broader processes, given that much of the original material may be absent.

Recent research has begun to explore some of these methodological questions, investigating the degree to which the investigation of different scales affects archaeological interpretation. Burger and Todd, for example, have employed the 'Modified-Whittaker multiscale sampling plot' in order to measure the effect of scale on surface recovery, adjusting both the spatial extent as well as the intensity (Burger and Todd 2006: 240). They found that by varying each of their three scale metrics: the grain (sample unit size), the overall spatial extent, and the intensity of survey, significant challenges to the conventional understanding of a survey landscape may be posed. Other, more statistically rigorous approaches have been recently employed to investigate archaeological landscapes, facilitated by the incorporation of GIS systems. Bevan and Connolly have applied a statistical approach to multi-scalar analysis based on Ripley's K function to survey data in Kythera, Greece (Bevan and Connolly 2006, also see section 6.4.2.). They point to the extreme variability of both archaeological and geomorphological data to suggest that multiscale processes can offer a more critical assessment of archaeological landscapes (Bevan and Connolly 2006: 229). Related explorations of multi-scalar phenomena have also incorporated fractal-based methodologies which have been applied to explore multi-scale self-similarity in urban development and settlement distributions, as well as in artefacts themselves, applying the methods to processes of fragmentation and distribution of materials (Batty and Longley 1994; Brown 2005).

2.10. Survey Data as Spatial and Scalar Pattern: Geostatistical Approaches

The previous sections have suggested that both spatial and scalar aspects of archaeological survey deal with perceptions more than reality; the metrics by which we choose to measure survey data largely determine the interpretation of that information. Since survey data, particularly in the more distributional approaches discussed above, yield a more-or-less continuous dataset, the question of how to break down this continuum and define the interpretative units becomes even more pressing. A well-known interpretative problem in this vein is what is known as the Modifiable Aerial Unit Problem, or MAUP (Openshaw and Taylor 1981). This statistical challenge arises from the demonstrated fact that, as either size or shape of an analytical window changes, the statistical properties measured within that unit will be

affected. This can, to an extent, ultimately lead to wildly varying interpretation (especially for the measurement of relationships as in regression analysis). One approach to mitigating this problem is to minimise the potential heterogeneity of the interpretative units by defining units that may be expected to have similar properties (Jelinski 1996). Unfortunately, while such an approach is possible in some cases such as landscapes, where discrete land types can often be articulated, such is typically not the case with archaeological data. Defining on-site versus off-site, for example, or town versus city, involves the selection of heavily subjective parameters that may not necessarily bear any resemblance to an original archaeological landscape.

2.10.1. Integrating Space and Scale

A second approach to providing spatially sensitive and scale-aware analysis that Jelinsky (1996) recommends is the application of geostatistics, introduced here but explored in detail in Chapter 6. Lloyd defines geostatistics as a body of statistical concepts that explores ‘spatial variation, spatial prediction, spatial simulation and spatial optimisation’ (Lloyd 2004: 1). Geostatistics offer potential in archaeology because of their ability to explore spatially heterogeneous processes, in which spatial characteristics are not uniform over a given region. As noted above, survey data may be affected not only by actual settlement patterns (themselves often quite heterogeneous), but also post-depositional processes and other geomorphological factors. The confluence of these suggests that archaeological distributions cannot be expected to exhibit completely random behaviour in space, the Poisson process (complete spatial randomness or CSR) against which most basic spatial statistical hypotheses have been tested (if they are tested at all). Instead, the spatial distribution of archaeological data can be considered to be non-stationary, where the mean and variance of the data change from location to location (Lloyd 2004). Pivotal to these analyses is a property referred to as spatial dependence, or what is sometimes referred to as Tobler’s ‘first law of geography’ (Tobler 1970). The principle states that similarities in observed geographic attributes vary inversely with the distance that separates the observations: the further apart two measurements are, the more dissimilar they are likely to be. Bevan and Connolly (2008) suggest that both ‘exogenous’ factors and ‘endogenous’ factors may contribute to the spatial dependence of surface artefact distributions. They further distinguish between induced and inherent spatial dependence where the former represents dependence that may be coerced by some external factor such as the distribution of environmental resources in a landscape, and the latter represents dependence inherent to the attribute being assessed, such as sherd fragmentation. The Murghab surface distribution, as will

be shown in later chapters, offers an array of such processes; and as an extension of the ‘exogenous’ category we may add the visual restrictions of the prevailing geomorphology which may falsely contribute to perceptions of spatial dependence by obscuring large swathes of the landscape.

2.10.2. Anisotropy and Directionality

Another aspect of geostatistics, quite new to archaeology but potentially very useful in the ridged landscape of the Murghab delta, is anisotropy, or directionality. Most archaeological survey projects, although they may recognise directional influences, tend to be isotropic; that is, they are assumed to exhibit the same behaviour in all directions. Longley and Batty (2003: 311) explain isotropic space as a uniform Euclidean concept, where all directions and locations are deemed equal. Survey data is often treated in such a manner, where sites or material scatters are assumed to exist in a uniform spatial environment. Other data that may affect movement or distribution of materials and sites in various directions may be recorded, but such information is typically qualitative and treated as supplemental to the primary datasets. One advantage of this directional uniformity is that its very simplicity facilitates the application of relatively straightforward models to investigate spatial behaviour. A classic example may be seen in the application of spatial models such as Central Place theory, often invoked to investigate interactions between sites in a region of social, cultural and economic homogeneity. Assumptions underlying the original model hold that societies within the regional space—and the space itself—are essentially uniform (e.g. Conrad 1978). Although modifications, such as weighting the relative prominence of particular centres, have been examined, the underlying assumption of spatial homogeneity has remained fairly constant (Crumley 1979).

Anisotropic studies in archaeology, by contrast, are uncommon, and few quantitatively rigorous analyses have been conducted outside of the more scientific aspects of the field such as magnetometry (Hus *et al.* 2003). An exception is in the sometimes problematic but developing study of cost-surface analysis, where slope is often cited as a potential anisotropic factor—it is typically easier to travel downhill than uphill, a fact that may influence ways in which people and animals may have moved through a landscape (e.g. Gonzales and Gergel 2007). However, with the growing awareness of the relevance of geostatistics to archaeology, researchers have begun to explore the importance of directionality in archaeological landscapes. Bevan and Connolly (2008) have demonstrated that beyond certain distances, there is a strong tendency for

similar surface densities to be influenced by the underlying geology of the landscape, effectively tracing a point at which directionality becomes a prime determinant of spatial dependence. Other non-archaeological applications have included directional or anisotropic kriging in creating predictive models, although Lloyd (2004) cautions that discontinuous data may best be suited to exploratory rather than predictive applications.

2.11. Survey on the Desktop: Remote Sensing and GIS

These archaeological patterns do not occur in a vacuum, and it is essential to understand aspects of the landscapes that contain them. Landscapes are, however, inherently qualitative, and it is often difficult to treat them as empirical datasets as we can with other variables such as sherd counts. Fortunately, the burgeoning field of remote sensing in archaeology offers a way around this problem, albeit an imperfect one. Originally used primarily as a visual tool to supplement or replace cartographic data, remote sensing data has evolved to a level where it can be included in quantitative analysis and complex algorithms, and seamlessly integrated into wider GIS systems (Parcak 2009). One of the more commonly used GIS data types, now increasingly derived via aerial or satellite remote sensing methods (see Chapter 4), is the Digital Elevation Model (DEM), which allows the encapsulation of topographical variation into discrete values not as easily obtainable in other kinds of imagery. More recently, with the increasing availability of multispectral data, various ground-truthed or wholly automated classification methods have been used in the identification of sites, routes and trackways (e.g. Ur 2003).

As with other technological innovations in archaeology, however, remote sensing data has also been the subject of significant theoretical debate (e.g. Atkinson 2004). Images of landscapes, despite their apparent accuracy, are only models, and subject to similar constraints of space and scale discussed above. What appears as a visual continuum is, in actuality, a series of discrete pixels, each of which may mask highly localised variability in the landscape (Adams and Gillespie 2006). Ideally, where possible, imagery should supplement rather than replace actual fieldwork, and relying on imagery without proper ground truthing may well result in erroneous interpretation of the data. A further problem may arise from image processing and interpretation techniques. The ease of reducing satellite imagery to thematic maps, classified images and other models hides a whole set of implicit assumptions and potentially significant parameters and, as with GIS systems, it is easy for archaeologists to be lulled by a seemingly infinite array of data,

aimlessly looking for patterns, and too often finding them without having asked the appropriate questions through which to properly interpret those patterns (Adams and Gillespie 2006).

In order to integrate the above concepts of space, scale and landscape, the role of Geographical Information Systems (GIS) cannot be overstated. The theoretical discourse surrounding GIS is peripheral to this research and has been discussed at length elsewhere (e.g. Conolly and Lake 2006: 1-10). However, two aspects are worth exploring here: its potential as an integrative tool for the spatial and scalar problems posed above, and the degree to which its use in Central Asian archaeology has realised that potential. Goodchild has defined spatial analysis as ‘a set of techniques whose results are dependent on the locations of the objects of analysis’, and such a definition encapsulates perfectly why GIS offers so much potential (Goodchild 1992). Moreover, the integration of categorical, numerical and even qualitative data within these systems has allowed archaeological space to be interpreted in various contexts, integrating archaeological and environmental variables with core spatial data. The incorporation of more complex applications of spatial statistics in conjunction with these expanded datasets has, in a sense, re-introduced a body of spatial and modelling research that had foundered, in part due to technology’s inability to keep up with intensive resource requirements. Even now, with GIS

firmly established in archaeological circles, software packages often offer only rudimentary implementations and documentation of complex geoprocessing and/or statistical procedures, and it is often all too easy to be lulled into a simplistic generation of a hydrological model or interpolation surface without considering the effects of modifying various complex parameters. As Connolly and Lake have cautioned, these tools therefore run the risk of reducing complex human behaviours into simplistic, overly abstract patterns, and the same may be said for archaeological landscapes as well. If these methodologies are not treated cautiously, they may work against their stated goals by reverting to overly deterministic interpretations of human settlement (Conolly and Lake 2006: 8).

With respect to the incorporation of GIS, remote sensing data and spatial analysis in Central Asian projects, the region has lagged both in theory and methodology. While the importance of these technologies is increasingly being realised in projects in Samarkand, the Tarim Basin, and elsewhere (Mantellini *et al.* 2008; Padwa 2005), most investigations have remained largely qualitative. Efforts have focused mainly on the data management and presentational facility of such systems. While some settlement pattern analysis has been conducted, such research often relies on traditional, visual approaches, and the extent of spatial analysis rarely goes beyond

basic metrics such as counts, areas and distances although methods such as Thiessen polygons have been explored (see above). There are signs, however, of a shift to more intensive GIS-based applications. Recent work conducted by the AMMD in the northeastern Murghab delta, near the sites of Auchin, has begun to incorporate more distributional approaches to settlement pattern analysis with the help of GIS (B. Cerasetti, pers. comm.). This work has employed multi-level and gridded collection strategies that are uncommon in Central Asia, and may indicate a growing awareness of the importance of spatial patterns in Central Asian archaeology.

2.12. Summary

This chapter has articulated a set of theoretical frameworks that will be used to guide the investigation of the settlement patterns in this section of the northern Murghab. At once disparate and integrated, these approaches are designed to provide as much context as possible given the complex survey environment and the limitations on prior regional knowledge. By interpreting aspects of spatial and scalar patterning of the material in the context of past and present landscapes, a convergence facilitated by technological and statistical as well as more traditional methods, a new perspective on the archaeological landscape will come forward. The methodological parameters of this multifaceted investigation are outlined in the following chapter.

Chapter 3. Methodologies

3.1. Overview

The research comprises a two-part project consisting of a desk-based component and a field component, each of which incorporates several distinct yet integrated procedures orientated towards a clearer understanding of the elusive, complex and largely hidden archaeological landscape of the northern Murghab delta. The intensive survey component in particular was designed to offer several original perspectives on the small and medium-scale distribution of material culture and archaeological sites across the area. The research builds upon the survey work that has been conducted in the delta since the 1950s, and narrows the analytical windows in order to explore new perspectives pertaining not only to micro- and macro-settlement patterns, but also key issues such as archaeological visibility and analytical scale.

3.2. Field Survey

3.2.1. Initial Preparation

During the week prior to the pilot survey in 2007 (see below), three days of field reconnaissance were allotted in order to assess the on-site feasibility of the project as originally envisioned in London. Pre-departure discussions with AMMD researchers familiar with the area suggested that heavy dunes in the Egri Bogaz region could be logistically difficult for research, both in terms of vehicle accessibility as well as survey implementation. Moreover, it was not known whether the time taken to travel from the Merv project premises in Bayramaly would be completely prohibitive.⁴

For the reconnaissance trips, a reference atlas was compiled from georeferenced raster and vector data. The raster imagery included 1:100,000 scale Soviet military maps and georeferenced ASTER images, to which aerial photographs were later added as they were

⁴The base of operations for the AMMD project is at a 'Sovkhoz' about a half-hour's drive north of Merv. This is a useful location for work to the east, such as at Takhirbai, but was found not to save any significant time when working on sites in the Kelleli or Egri Bogaz area.

acquired and georeferenced.⁵ The initial vector datasets consisted mainly of sites identified by the AMMD survey as well as regions of interest identified during the desk-based portion of the NMDS research. While these maps proved useful to have on hand, they were primarily used to gain a general sense of direction or feel for the overall character of the landscape, as the resolution was generally too low to provide any positive identification of specific features. Moreover, the roads and tracks delineated on the Soviet maps are approximate and largely out-of-date in a landscape subject to frequent and undocumented change. Since there are so many new (albeit small) roads associated with agricultural development, pipeline construction and maintenance and other reasons, the Soviet maps provided only a weak navigational aid for this area.

3.2.2. Pilot Survey: Sampling Strategy and Selection of Initial Grids

The NMDS survey was designed to address a pressing need for a better understanding of inter-settlement interactions at what may be considered a sub-regional scale. The sheer geographic scope of the surveys to date offers very little perspective on occupational distribution at this level, and the lack of sufficient data in this portion of the northern Murghab suggested that the region would be ideal for this approach. There are, of course, well-established theoretical and methodological precedents for intensive survey (Bevan and Conolly 2004; Bintliff and Snodgrass 1988; Redman 1982; see discussion in Wilkinson 2000: 227). The survey rests largely on the premise that, since the northern Murghab landscape is highly complex, preconceived notions of site boundaries and subsequent extrapolations of settlement patterns employed in previous research may be overstated or simplistic, and that a somewhat novel approach to intensive survey in the region, designed to provide a full spatial continuum, may offer better insight (Bevan and Conolly 2006). In this vein, the research seeks to avoid preconceived notions of sites, and to proceed from a perspective of ‘distributional’ archaeology (Ebert 1992), where the primary dataset is the continuum of surface artefacts. The research is not, however, intended to fully reject the theoretical notion of site, as is sometimes advocated in the siteless or anti-site survey approach (Dunnell 1992). However, while site-based theoretical

⁵ In parts of Central Asia, higher resolution Soviet military maps of either 1:10000 or 1:25000 resolution are available, and these have been used effectively in the Middle Zeravshan Valley (Stride *et al* 2009). Unfortunately, due to more restricted accessibility in Turkmenistan as well as the highly sensitive nature of the landscape due to oil and gas reserves, these could not be obtained for the project, and difficulties have been reported in related projects as a result of attempts to procure higher resolution maps.

models are referenced in the research and analysis, these conceptual constraints are held to a minimum.

The research was designed and conducted by the author, with the field assistance of about ten people. These included workers from the nearby villages as well as several volunteers associated with the Ancient Merv Project. The survey was conducted over two consecutive autumn seasons in 2007 and 2008 and the first part of the spring season in 2009, comprising a total of approximately eight weeks in the field. Autumn is the ideal time for field research in southeastern Turkmenistan, due to the relatively mild conditions following the intense summer heat (often over 40°C that may last through early or mid-September). Precipitation during this period is extremely rare (although a few rainy days were experienced during the 2008 season), so no wet-weather gear was required, rendering conditions quite amenable for archaeological survey. The project was divided into two parts: a pilot survey in 2007, covering 4 km², and the main survey the following year designed to link all of the survey grids in a continuous two-dimensional dataset. The pilot survey consisted of four discretely placed grids, each comprising one square kilometre, and a fifth which was abandoned due to heavy agriculture (Figure 22). These were selected to address perceived variability in topography and concentration of surface material. The initial separation of the grids was a key factor in addressing potentially distinctive patterns in different landscapes. While the initial sample of discrete, unconnected grids precluded an investigation of the full spatial continuity of material in the initial phase of the survey, this became possible with the completion of the full survey in 2008. Table 1 describes the initial survey grids, the prevailing topography based on a visual assessment of satellite imagery, and known Bronze Age sites identified in earlier surveys. Grids were aligned according to the cardinal points and adjusted so that grid corners coincided with UTM coordinates in multiples of 100m (e.g. 393500, 4250000), in order to facilitate the placement of subsequent survey grids.

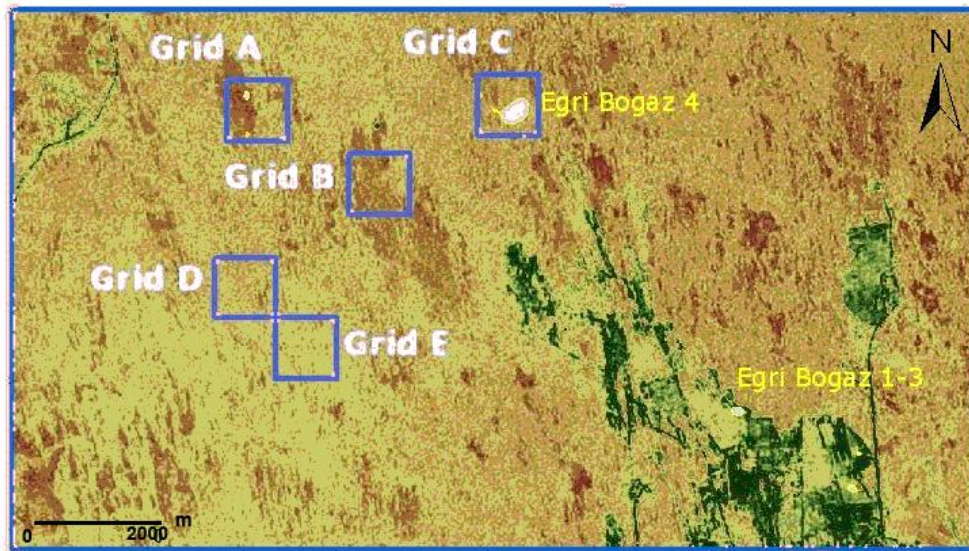


Figure 22. Location of Initial Grids

Table 1. Pilot Survey Grids (2007)

Grid	Landscape Type	Known Sites (as noted by the AMMD)
A	Predominantly Takyr	AMMD 717, 718 (MBA/LBA)
B (abandoned to heavy cultivation)	Heavily cultivated takyr	None
C	Predominantly dunes, some anthropogenic activity	Egri Bogaz 4, AMMD 753, 720 (MBA/LBA)
D	Primarily dunes	None
E	Primarily dunes, slightly higher vegetation cover	None

While the fieldwalking methodology was the same for all grids, secondary research objectives were identified for each individual grid in the pilot survey. Grid A was approximately centred on two sites previously identified by AMMD researchers, AMMD 717 and 718, on the eastern edge of a large takyr. The high visibility of the takyr surface against the dunes facilitated a closer look at this topographic boundary and its relationship to site visibility and surface distribution. Moreover, it offered the chance to examine small settlement locations several kilometres from a known, and more substantial, archaeological presence. The main feature in Grid C was the site of Egri Bogaz 4 and two additional small sites identified by the AMMD as 753 and 720. This grid provided an opportunity to gain a clearer perspective on significant material scatters, as well as the degree to which nearby concentrations of surface material may be seen as part of a broader settlement complex or as isolated entities. Grids D and E were situated a few kilometres south of grid A, in a largely unexplored dune region, and addressed the apparent settlement void south of the Kelleli and Egri Bogaz groups.

3.2.3. Fieldwalking Methodology

The full survey area consisted of 11 grids, sufficient to fully integrate the four grids in the pilot study and a manageable number considering time constraints in the field. Each grid measured one square kilometre, and designated by a letter from A-N.⁶ Two exceptions were Grid M, which was shortened by 100m and an additional 100m wide line between Grids H and C, designated CW. These modifications were necessary based on the irregular placement of the initial grids, but the changes were notational and had no effect on the research. With these exceptions, each grid was divided into 100 single-hectare squares, numbered in columns from 00-99, representing the southwestern and northeastern corners respectively. These squares were, in turn, subdivided into 20m x 20m collection units, or 25 collection units per hectare (Figure 23). This squares-within-squares hierarchy was designed primarily as a conceptual tool to reference the two-dimensional surface distribution at multiple analytical scales. Additionally, it offered a convenient system to reference perceived sites and materials visually. Throughout this thesis, feature and artefact locations are therefore specified using the grid square rather than the smaller collection unit for easier identification (i.e. M54).

⁶Two grids, I and J, were initially included to cover the regions north and south of Grid C, and an additional grid, K, was placed in order to explore the increasing sherd scatter in the south of the survey area, but these had to be abandoned due to time constraints and are not included in the NMDS survey map.

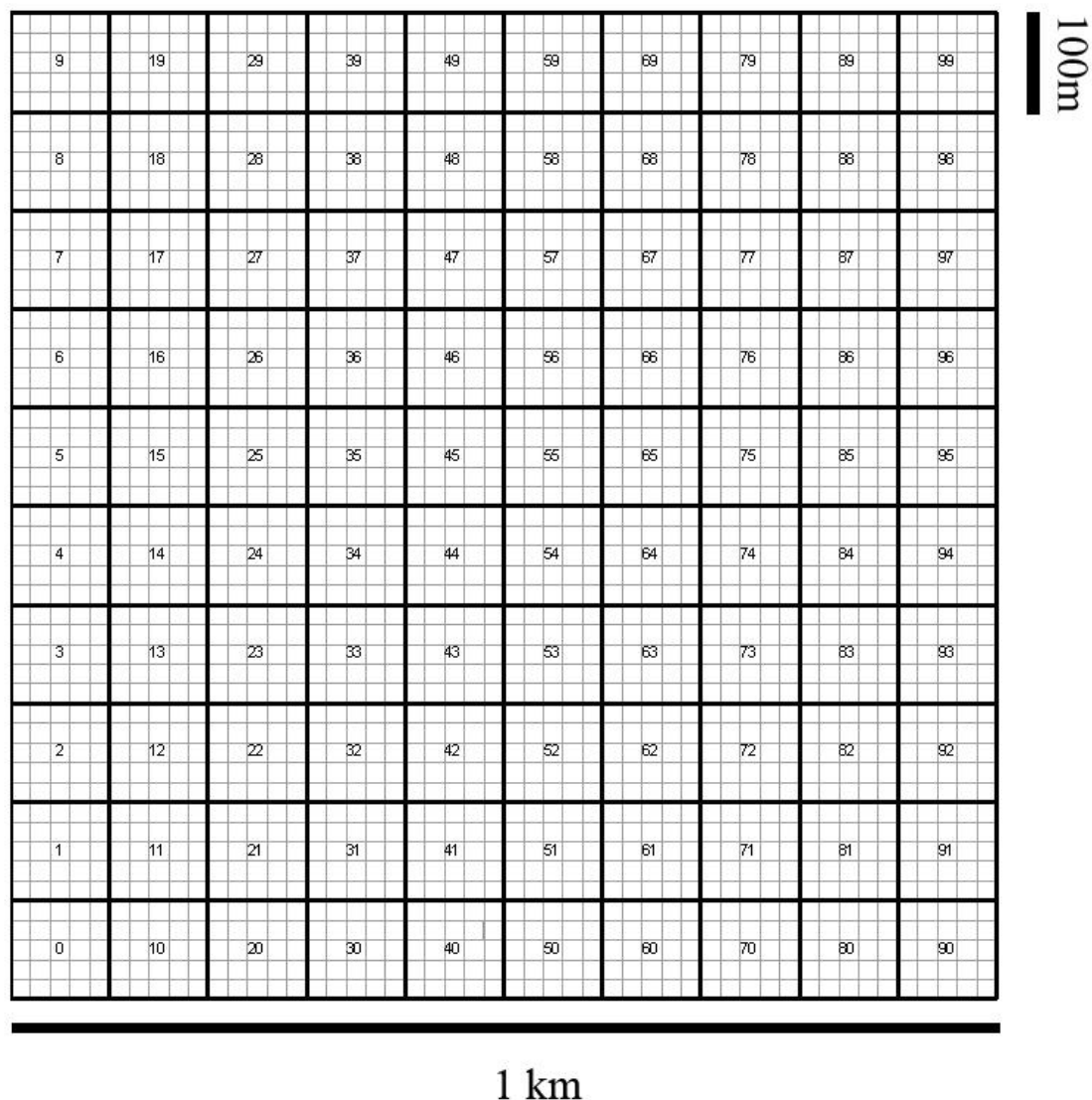


Figure 23: NMDS Grid Format

Field-walkers were spaced 20m apart, beginning at 10m along the baseline in order to prevent overlap between adjacent tracts. Starting points were fixed via a Garmin Etrex GPS unit, with an accuracy of 5m, and distances between walkers were measured by pacing. Each walker was given a packet containing small bags for diagnostic collection (see below for a definition of ‘diagnostic’), labels, a pen and a compass. At a given signal, participants walked along transects, reporting the total number of sherds observed on the ground, total number of ‘pakets’ i.e. diagnostics), and a broad category of land cover or features (e.g. dune, takyr, shell) at 20m intervals.

While the gridded system provides a structured methodology to the field survey, it is analytically restrictive due to its high degree of abstraction. Reducing a continuous distribution of surface material as a series of squares and grids can result in false linearities and patterning that have no bearing on archaeological reality. To mitigate this effect, the survey area was divided into a series of 9 analytical units (Figure 24). These were determined based on visual assessments of surface distributions and land cover, and their characteristics will be examined in more detail in the next three chapters.

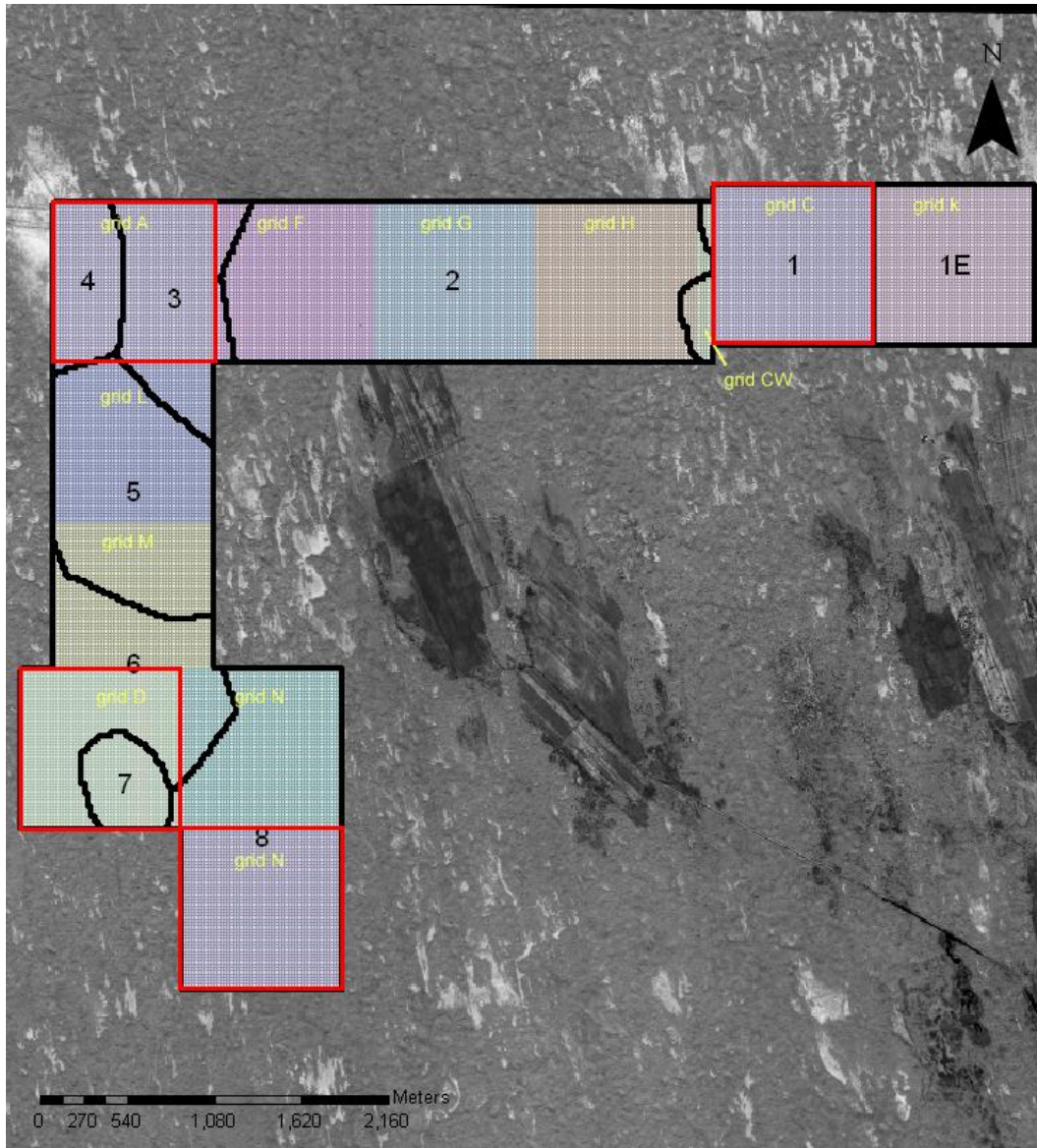


Figure 24. Survey grid layout with superimposed analytical units. Pilot grids (see Figure 22) are delineated in red.

The initial recording strategy, in keeping with the landscape aspect of the research, was to sketch the general character of the land cover in each square. While this method was employed for the first grid that was fieldwalked, Grid C, it soon became evident that this recording strategy was far too general to capture the deeply varied landscape. Beginning with the second grid surveyed, a general land type was recorded for each collection unit, a method that proved useful for general reference, but was unsuitable for quantitative measurement as it relied on a subjective, and often inaccurate, on-the-fly assessment from each fieldwalker. The post-survey acquisition of Quickbird imagery in November 2008 offered a far more effective way to categorise the landscape, as the high resolution provided a clear look at land cover types at high resolution (see section 4.4, 5.5). While subtle changes in the land cover, primarily resulting from windblown sands, may have occurred in some areas, these were generally too insignificant to significantly impact even small geomorphological features. Sherd counts for each collection unit and additional notes were recorded on a form so that both square and collection unit data were kept on a single sheet (Figure 25). Due to the enormous number of sherds, it was only possible to collect 'diagnostic' sherds (i.e. decorated artefacts, rims, handles and bases) and small finds. The identification of diagnostics upon collection, especially when the survey team has varying degrees of experience, may result in some degree of observer bias (Van Leusen 2002: 4-6; Alcock *et al.* 2000). However, as the survey was designed to address general spatial issues rather than the specific quantities of diagnostic sherds, this issue was not expected to significantly impact the study. Qualitative information such as surface features, modern utilities and topographies were also recorded on the forms and more carefully fixed via GPS when necessary.

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Figure 25. NMDS Field Record Form

While the same general survey methodology was maintained during the 2008 field season, several changes are worth noting. A Garmin Etrex Vista Hcx was purchased for the project which offered a consistent accuracy of 3-4 m in the field, as well as faster satellite acquisition. Additionally, an improved data-entry screen greatly facilitated the on-site recording of features. Beginning in the 2008 season, a track-log was maintained for each day's survey. In addition to being a useful tool for navigating an off-road desert landscape, it also provided a visual record of fieldwalking error. A further potential benefit of the Vista was its compatibility with a new software package called Moagu (www.moagu.com) which converts raster imagery into a GPS-compatible format. While this method was tried with both ASTER imagery and aerial photography, the utility was somewhat difficult to manage, and the load time was prohibitively slow. While this tool appears to have great potential for future work, and would probably have been effective using smaller images, printed maps were found to be far easier to use in the field.

3.3. Pottery Analysis

Analysis of the diagnostic material was primarily orientated towards providing general typological and chronological information that would be useful in examining the distribution of Early, Middle and Late Bronze surface artefacts, although later material was also examined. Before discussing the methodology, it is necessary to address a significant chronological problem. The Bronze Age chronological horizon covered by the survey is small, spanning only a few centuries. Moreover, the pottery forms in the region tend to be stylistically conservative, and their composition from local alluvial clays changes little over time (Hiebert 1994a: 41, also see petrographic discussion in section 5.11). As a further complication, the persistent Namazga chronology is quite antiquated and geographically overextended, and regional variants of the general Namazga typologies are only partially understood. The problems with distinguishing pottery from subsequent chronological horizons are well known; examples include the Middle/Late Bronze transition in Syria and the Iron Age/Achaemenid horizon in much of western and Central Asia (Philip 2002; Casana 2003; Genito 1998: 151, footnote 5). Since changes in material culture need not coincide with chronological windows developed by archaeologists, the onset of a new chronological horizon may not always be discernible through surface survey without the benefit of excavation. In many surveys, this problem is glossed over with a broader diachronic approach—if a survey spans a few millennia, confusing a few centuries is less of a problem. The NMDS survey, however, zeroes in on just such a horizon, and this limitation must be taken into account in conducting the research.

Fortunately, there is a substantial body of literature that has focused on these specific problems, and the Margiana variants of Namazga V and VI typologies have received significant treatment. Most useful to this study has been Hiebert's chronology, derived from the 1989 deep sounding on Gonur North, which offers not only an outstanding written and visual resource but also an excellent analysis of perceived changes over a short period of time (Hiebert 1994a: 39-73). Salvatori's excavations on Adjı Kui 1 and 9 provide another outstanding resource, as well as his reports on the ceramics from the Namazga V cemetery on Gonur North (Salvatori 2002; 1995). P'yankova (1993) and Udeumuradov (1993) have also provided in-depth analyses of Murghab ceramics in broader regional context, although illustrations are often small and forms more difficult to identify.

With the aid of these resources, and the professional assistance of Sandro Salvatori and Maurizio Cattani at the University of Bologna, it was possible to assign a broad date to 620 of the 707

collected diagnostics of which 509 could be classified with reasonable certainty as Bronze Age materials. Of these, 77 could be tentatively assigned to the Middle or Late Bronze Age, and about 8 to the terminal or final Bronze Age (late Namazga VI, including 5 steppe coarsewares). While the sample was often too small to comfortably sustain statistical evaluation, the number of sherds was sufficient to examine general trends (see Chapters 5 and 7). Sherds were photographed and entered into a database along with information on sherd size and abrasion. This database could then be linked to the survey data through a GIS system (see below). Finally, it is worth noting that further, more informal, chronological assessments were also conducted in the field based on general shape typologies and fabrics.

As an adjunct to the pottery analysis, a small petrographic study was conducted (see section 5.9 for detailed methodology). The purpose of this investigation was to determine if any broad classes could be identified that may offer additional insight into the chronology or provenance of the surface material. A feasibility study of six sherds was conducted after the 2007 season, to which an additional 12 sherds were added upon completion of the survey. Material was chosen to reflect a range of types and fabrics based on visual observation, selected both from the Egri Bogaz 4 region as well as more remote areas in the western part of the survey area in order to evaluate any potential geographical variation.

3.4. GIS and Spatial Analysis

3.4.1. Preparation of the GIS and Existing Data from the AMMD GIS

The GIS used for this study manages both existing raster and vector data from the AMMD project and new data obtained for the NMDS survey. The key raster datasets, explained in more detail below, include multispectral ASTER imagery, CORONA imagery, Soviet aerial photographs, and high resolution Quickbird imagery, the last of which was acquired in November 2008. Some of the technical aspects of these satellites will be discussed in more detail below, but it is worth mentioning that the Quickbird imagery was obtained during the second field season, effectively providing a live image of the study area. Unfortunately, the imagery was acquired too late to be of use in the initial survey design, although it played a significant role in the post-processing and analysis of the data. In addition to these raster sets, a large archive of vector data was generously provided by the University of Bologna, which proved invaluable in the research. The primary spatial dataset from Bologna contained vector

data of all recorded sites in the Murghab. For the purposes of this research, a subset of this data representing the Bronze Age sites was created. Sites dating from the Iron Age and later do not comprise a significant component of this research, and are only occasionally included as a general reference. Additional information about the AMMD sites including chronology and comments was included in an accompanying Microsoft Access database that could be integrated with the GIS data. Additional raw data from the AMMD GIS system (cited hereafter as AMMD GIS) was available for further reference. Use of these datasets is noted in the text where relevant.

3.4.2. NMDS Datasets

The area covered by the NMDS survey is represented by a single polygon shapefile containing all 27,500 collection units. In order to facilitate integration with the existing AMMD data, the NMDS dataset was projected into UTM coordinates, using the WGS 84 ellipsoid (Zone 41N). Each collection unit was assigned a unique identifier containing the grid letter, square number (00-99), and horizontal and vertical coordinates of its corresponding centroid [e.g. A233030]. Included within the shapefile are corresponding sherd and diagnostic totals as well as a comment field. During the course of the research, many additional shapefiles and maps were created based on the GIS analysis and evaluation of the remote sensing algorithms. These proved to be very useful not only in analysis, but in visual presentation as well.

A companion database, built in Microsoft Access, comprises an inventory of all of the diagnostic material and small finds collected during the course of the survey. In order to provide a spatial reference for these diagnostics, each was assigned a random point within its corresponding collection unit. This process allowed the diagnostic material to be integrated with the raw sherd counts, facilitating both a visual and spatial examination of the material. In this way, broad trends in material type and chronological shifts could be explored where possible.

3.4.3. Spatial Analysis

Whereas many other GIS-based projects in Central Asia have focused primarily on using GIS applications for data management and presentation, the NMDS project placed much more emphasis on spatial analysis functionality to make sense of a highly complex distribution of

surface materials and occupational areas. As in other projects, a substantial portion of these investigations was initially visual: both material from the original AMMD research and the new datasets were subjected to intensive visual examination. Foremost among these was the detection of probable occupational areas as well as the relationships between these and the landscape, as interpreted both from fieldwalking data and remote sensing imagery. A second, and more complex, application of spatial analysis incorporated a suite of advanced statistical methods. To apply these methods, the entire surface distribution was treated as a point pattern in two-dimensional space, where either individual artefacts or collection units were represented by discrete points in a spatially continuous pattern (for details see Chapter 6). While older global statistics such as the Clark-Evans nearest neighbour test (Clark and Evans 1957) were employed as a starting point, newer methods that focused on spatial autocorrelation and multiscalar analysis, such as the G_i^* statistic (Getis and Ord 1992) and K function (Ripley 1977) respectively, were employed to deepen this understanding. Additional methods were borrowed from geostatistics, designed to work with spatially heterogeneous and non-stationary distributions. Of particular interest was the anisotropy, or directionality, of the landscape, and its potential influence the material scatter from the perspective of settlement orientation, geomorphology, and recovery bias. Two methods were employed for this exploration: variography and angular wavelet analysis, each of which will be further explored in section 6.5.

3.5 Remote Sensing

The second aspect of the desk-based analysis was an evaluation of the utility of remote sensing technologies for research in the Murghab. Using the ENVI image processing software, various techniques including band combinations, classification algorithms and principal components analysis (PCA) were explored to assess the potential for site identification and visibility analysis as a supplement to field survey. Because of the complexity of many of the procedures, the specific methods will be addressed in the corresponding sections in Chapter 4. Due to the limitations of this research, discussion will focus primarily on the multispectral ASTER imagery, the high resolution Quickbird Imagery and Digital Elevation Models (DEMs), and aerial photography and CORONA imagery to a lesser extent. Other datasets, while useful for the research, are not addressed in detail.

This section describes the general methodology of remote sensing analysis as applied to the archaeological landscape of the northern Murghab, as well as some facets of the acquisition and

nature of the imagery. Specific technical evaluation will be reserved for Chapter 4. Ultimately, the use of remote sensing data served multiple purposes. The first was to examine its usefulness as a tool for developing a preliminary understanding of a complex landscape prior to actual fieldwork in the region. Low cost and even free imagery, viewable via products such as Google Earth, are widely available although their usefulness in planning an intensive survey in the northern Murghab had not been tested.⁷ By comparing the most recent ASTER imagery with aerial photographs from the 1980s as well as with the CORONA imagery from the late 1960s, questions of land type and visibility, as well as a preliminary investigation of topographical features, could be developed.

3.5.1. IMAGERY SELECTION

ASTER IMAGERY

The multispectral ASTER imagery was acquired as part of the AMMD data and consisted of a freely available, secondary surface radiance product (A. Perego, pers. comm.). The imagery has already been atmospherically corrected and consists of 12 spectral bands rather than the standard 14 bands included in a full ASTER product. Of these, the research employed the first nine bands which consist of visible/near infrared (VNIR) bands 1-3 and short-wave infrared (SWIR) bands 4-9 (Figure 26). Since more intensive lithological or mineralogical spectral analysis was not the focus of the work in the Murghab, the product was sufficient for the research. A single ASTER granule, acquired in 2001 and comprising 3600 km², covers the entire Bronze Age delta and much of the Merv Oasis.

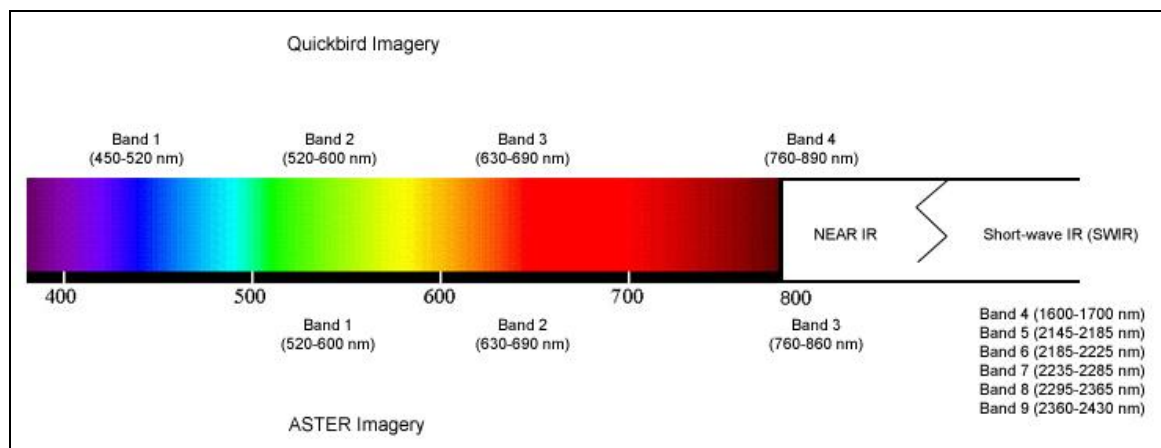


Figure 26. Comparison of Spectral Bands for ASTER and Quickbird Imagery

⁷Until mid-2009, only Landsat imagery had been freely available on Google Earth for the entire study region. The recent addition of high resolution SPOT imagery for much of the Karakum region, while not incorporated in the study, offers excellent potential for wide-ranging site and landscape studies.

Since the ASTER product is roughly georectified in advance, significant geographic manipulation of the imagery is sometimes unnecessary. However, closer examination revealed a significant spatial discrepancy between the georeferencing of the ASTER and Quickbird imagery. To allow for cross-comparison and data fusion between these two, a simple linear shift of 50m to the east and 120m to the north was applied to the ASTER data. Even the high resolution Quickbird imagery may be subject to a horizontal error that may exceed 20m (Wang *et al.* 2004).⁸ Ground control points were evaluated in the survey area to assess this potential for error, including several along the exposed pipeline and a large well in Area 2, the only available fixed locations in the survey area. These control points were found to lie within a few metres of the corresponding pixels in the satellite imagery. Given that the GPS error itself was in the range of 5m, the Quickbird error did not adversely affect the survey.

QUICKBIRD IMAGERY

The highest resolution imagery used in the research was the Quickbird imagery, a Digital Globe product purchased through EurImage (www.eurimage.com). The Quickbird imagery offers data from two imaging sensors, a greyscale panchromatic sensor, at 0.6m resolution, and the multispectral sensor which provides imagery in four bands: Blue, Green, Red and Near Infrared (Lasaponara 2006). While Quickbird coverage is readily available—although at significant cost—for much of the Murghab delta, the imagery available as of 2008 did not extend far enough north of the Merv oasis, and had to be specifically tasked. Figure 27 shows the coverage area. The Quickbird imagery comprises a rectangle of approximately 64 km² within the full 140 km region of study. While only a small portion of the northern delta is covered by the image, this area was sufficient to cover the entire fieldwalking survey as well as a substantial representation of the landscape variability in the survey area, incorporating broad areas of dunes, takyr and agricultural fields. While all previously identified sites in the survey area were covered in the Quickbird image, the only site of the original three in the Egri Bogaz group that could be included was Egri Bogaz 1.

⁸ Official DigitalGlobe specifications estimate the horizontal error for Quickbird imagery at 23m (CE 90), a measurement of the minimum horizontal diameter of a circle that contains both the control point and its geolocated counterpart in 90% of cases. The mean error is estimated at 13.5m (Kudola 2003)

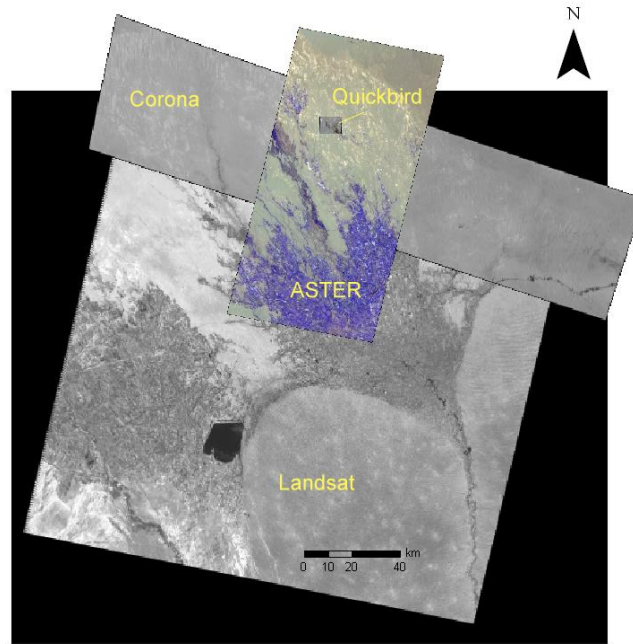


Figure 27. Satellite Imagery of the Murghab: Landsat, ASTER, CORONA, and Quickbird

AERIAL PHOTOGRAPHY

Included in the AMMD imagery archive is a group of aerial photographs acquired by Soviet military flyovers in the mid 1980s of which one series, E-122, pertains to the northern part of the Murghab delta (B. Cerasetti, pers. comm.). Photos E-122 2330 and 2332, covering the survey area, as well as E-122 2348, covering the sites of Egri Bogaz 1, 2 and 3, were georeferenced to the Quickbird imagery.

CORONA IMAGERY

The final satellite-based dataset consisted of imagery from the CORONA satellite, originally acquired in 1964 and included in the AMMD database. The 14m spatial resolution was comparable to the VNIR bands of the ASTER imagery. Five CORONA tiles, reference numbers DS009038001 AF008 through DS009038001 AF012, represent the entirety of the Murghab delta, of which AF 011 comprises most of the distal portion of the alluvial fan including the survey area. The images obtained from the AMMD survey were georeferenced in the 1990s by the Italian team (B. Cerasetti, pers. comm.), although there was a significant margin of error (for an excellent description of georectification issues in CORONA imagery, see Hamandawana *et al.* 2007). In order to improve the accuracy within the survey area, a spatial subset of the CORONA tiles corresponding to the survey area was then re-rectified using the higher-

resolution Quickbird imagery. Unfortunately, the lack of clearly identifiable built features in the CORONA imagery meant that topographical features, usually visually prominent takyr, had to be used for the georectification. While not ideal, the method offered an improved horizontal accuracy at the regional level, which was adequate for a visual analysis.

3.5.2 Visibility and Landscape Analysis

Prior to the pilot survey conducted in 2007, an initial assessment of the ASTER imagery was undertaken in order to gain a clearer understanding of the spectral characteristics of the northern Murghab landscape, and to use this remotely acquired information to assist in the initial placement of each isolated grid of the pilot survey. While the preliminary knowledge of a few sites as well as a general character of the landscape could be ascertained from the existing research, the finer detail of topographic and land-use variations—and their relationship to the settlement pattern—remained unknown. Using broad classification algorithms described in detail in Chapter 4, it became possible to gain a better sense of the variations in the landscape even prior to ground truthing. With the completion of the pilot study, it then became possible to examine the initial relationship between the landscape and the potential for archaeological recovery in the designated survey grids. These questions concerning visibility and land cover were explored more fully with the acquisition of the Quickbird imagery and concurrent completion of the full survey in 2009.

3.5.3. Site Identification

A second goal was to examine the extent to which methods of remote site identification such as those used in Anatolia and elsewhere could be applied to the Murghab, with particular focus on the Egri Bogaz study area. This investigation, described in detail in Chapter 4, aimed to explore both the visual potential of the imagery—both in terms of site identification using standard image enhancement techniques, as well as the potential advantages of multispectral image processing through the use of more advanced image processing techniques. These relied most heavily on supervised and unsupervised classification techniques and Principal Components Analysis. An additional examination employed ASTER and SRTM DEMs to evaluate the potential to detect sites topographically (see Ur *et al.* 2006).

3.6. *Integration with Existing Data*

It is necessary to comment briefly on the procedures used for data integration in this project. In recent years, there has been a growing awareness of the difficulties associated with comparative research, given that few research projects adhere to exactly the same procedures and parameters. Differences in research questions and methodologies—in the importance afforded to certain artefacts, whether to collect material or merely study it in the field, what parameters to record, etc.—all of these issues become even more problematic when an attempt is made to explore many disparate datasets from different research projects. The advent of newer technologies, in this regard, seems at times both a blessing and a curse. Researchers clamour at archaeological conferences for the need for scalability, ontology development, standards for interoperability, so that multiple and various projects can be incorporated (e.g. Isaksen *et al.* 2009). While some progress has been made on these fronts, the solutions often tend to be as proprietary as the original projects, and true scalable electronic resources are hard to come by.

For this reason, it is worth noting what the NMDS research can and cannot do with respect to integration. Because the research is not focused on ‘sites’ per se, it is not directly structured for full integration with the existing AMMD database. Although AMMD site designations are used as reference points throughout the study, the definition of site in the northern Murghab is intended to be an outcome rather than a starting point of the research. In this sense, the ‘siteless survey’ (Dunnell and Dancey 1983) is a key methodological theme, albeit not ultimately a mantra. Because of the vastly different methodologies and datasets, it is not envisioned that the NMDS systems will become fully compatible with either the AMMD database or other Central Asian archaeological databases. However, the structure does facilitate comparative assessment of both datasets, as well as useful ground control against which to conduct investigations in other areas, and ongoing research collaboration between these projects further facilitates qualitative integration.

3.7. *Test Pits and Investigation of Subsurface*

The above methodologies focus entirely on surface observations. However, significant geomorphological and post-depositional processes have unquestionably altered the distribution of surface artefacts over the past four millennia, and it is necessary to gain some sense of the relationship between surface distributions and subsurface archaeology. In order to explore this

relationship, a test-pit strategy was employed. This approach served a dual purpose. The first objective was to investigate the presence or absence of cultural stratigraphy in areas that displayed signs of occupation, either in terms of dense cultural material or surface features. A secondary aim was to investigate the relationship between topographic variation and cultural material, as well as the effect that erosion may have had on the subsurface cultural horizons. In addition to gaining a better understanding of the archaeology, the subsurface investigation was designed to gain further insight into both natural and cultural stratigraphy.

Since surface scatters are not necessarily a direct indicator of occupation, some care was required in determining where to position the test pits (for detail see section 5.6). Furthermore, with limited time and resources available to conduct these pits, a full systematic sampling strategy could not be employed (but see Nance and Ball 1986 for discussion). Test pits were dug as 1m x 1m x 1m units, oriented in the cardinal directions, and material was collected according to broad stratigraphic context. Pits were to be taken to the top, rather than through, cultural layers, as a fine-grained stratigraphic analysis was beyond the scope of the study. In a few instances, augering was employed to further examine selected areas between test pits.

3.8. *Summary*

The methods employed thus offer an integrated approach to understanding the settlement patterns in the northern Murghab delta. While the survey itself is the primary focus of this research, it is supported throughout by further analyses of spatial distribution and landscape through the technological approaches outlined in this chapter. The following three chapters will present the results of these findings, beginning with an assessment of the remote sensing data in its applicability to landscape interpretation, visibility and site detection.

Chapter 4. Results: Remote Sensing in the NMDS Landscape

4.1. Overview

With the recent proliferation of publicly available satellite imagery, remote sensing applications in the field of archaeology have begun to come into their own (e.g. Parcak 2009). Several recent projects have demonstrated the utility of satellite imagery in site identification. NASA's SRTM elevation models, for example, has proven highly successful in facilitating the semi-automated detection of tell sites in northern Syria (Menze *et al.*). Ultra-high resolution IKONOS imagery has been used in conjunction with older CORONA imagery to detect flat sites that were ploughed out in antiquity (Philip 2002). Remote sensing has also proven successful in identifying wider-scale interactions, such as the identification of linear hollows, inter and intra-site pathways attributed to the movement of people and pack animals in antiquity (Ur 2003; Wilkinson and Tucker 1995). In the Murghab, the focus has largely been on the large-scale, delta-wide relationships between settlement and geomorphology (e.g. Cerasetti 2006). While remote sensing data, particularly aerial photography, has helped to identify some large Murghab sites, these methods have not been effectively applied to the northern delta.

One benefit of satellite imagery is the ability, through image processing, to simplify extremely complex landscapes into data that can be interpreted using quantitative techniques. Of course, the reduction of a landscape into a few spectrally derived categories risks obscuring subtle variations in topography and geomorphology (Adams and Gillespie 2006). However, the process does offer the chance to identify and examine characteristics that might otherwise remain elusive, such as general categories of land cover or land use. This simplification can be useful in testing the potential for site detection in a landscape, and in determining which land categories may be more conducive to site recovery. The visual barriers to site detection in an obstructed landscape have long been recognised as problematic (Van Leusen 2002 4-12), and disclaimers acknowledging these issues have appeared in the published literature for decades. Unfortunately, the issue has rarely been examined systematically. Given the broad geographical scope of the Murghab surveys, it is essential to explore the effect that visibility bias may have on past and current archaeological prospection.

In keeping with the overall direction of this study, and recognizing the need to explore the survey area at different levels of analysis, visibility was addressed using scale as a prevailing conceptual framework. At the broadest level, ASTER imagery was used to examine the Bronze Age settlement landscape as a whole, in order to identify broad patterns that may affect the potential for site recovery in the NMDS region as compared to elsewhere in the Murghab delta. Narrowing the scope, a similar strategy was applied to the survey area itself, designed to identify different local and regional factors that may affect recovery in various locations. This analysis begins with a general assessment of the remote sensing data, and moves towards a more detailed investigation of multispectral image analysis. Since the highest resolution Quickbird imagery was obtained quite late into the course of the research, most of this work utilised the ASTER imagery, and analyses where Quickbird imagery was included are clearly identified. The chapter takes a top-down approach, beginning with an investigation of general characteristics of the remote sensing data, then examining these more closely with respect to issues pertaining to geomorphology, visibility and site-identification issues.

Prior to the analysis, a disclaimer is necessary. Remote sensing is a broad term, and it is important to articulate what it means with respect to the current research. Essentially, remote sensing reflects a method of data acquisition—not of interpretation. The ways in which such data may ultimately be utilised are numerous, and range from simple thematic displays to sub-pixel spectral analyses of various minerals (Adams and Gillespie 2006). In Central Asia, satellite and aerial imagery have been used extensively to understand the geological underpinnings of the Kopet Dag and Karakum—information heavily utilised both by the oil and gas industries as well as in investigations of the desiccation and salinsation of the Aral Sea region and Amu Darya rivers (e.g. Shi 2007; Orlovsky and Orlovsky 2002). With respect to Murghab archaeology, the primary focus has been on the reconstruction of palaeo-hydrology. Additionally, geophysical survey, also technically in the remote sensing category, has been utilised in conjunction with high resolution IKONOS imagery at Merv (Herrmann 1994) .

With these limitations in mind, the use of remote sensing is here employed to address questions of feasibility, and seeks to identify the extent to which this data can assist in making sense of the distribution of archaeological materials in an obstructed landscape. In this respect, three lines of enquiry are pursued. The first addresses archaeological visibility, and the degree to which it may be quantified. A second avenue deals with the potential for identification of archaeological sites in the Murghab, through both DEMs and multispectral imagery. Underlying each of these

is a third aim—the deeper understanding of the geomorphological landscape as detectable via remote sensing, and its ultimate relationship to the distribution of settlement and material.

4.2. *Visual Analysis of Remote Sensing Data*

4.2.1. Aerial Photography

Two aerial photographs from the E122 series (see section 3.5.1), 2330 and 2332, were used in the analysis, georeferenced to the high-resolution Quickbird imagery of the area. For comparative purposes, two other photographs in the series, one covering the Kelleli sites, and one covering a portion of the Adji Kui settlement region, were also georectified. An initial investigation of these photographs revealed several problems with the imagery. The photographs, while offering a high spatial resolution, are very grainy, and image artefacts are common (Figure 28). These typically take the form of small brightness anomalies, although broad horizontal striping tends to occur in some of the more uniform sanded areas. The edges of the photographs are dark compared to the centres in each photograph, although features in these areas may still be enhanced using simple histogram modifications. While it is possible to use more advanced image enhancement techniques such as de-striping algorithms or Fourier-based noise reduction techniques (Albani and Klinkenberg 2009), these were beyond the scope of research and not deemed to be necessary in gaining an overall sense of the visual landscape.

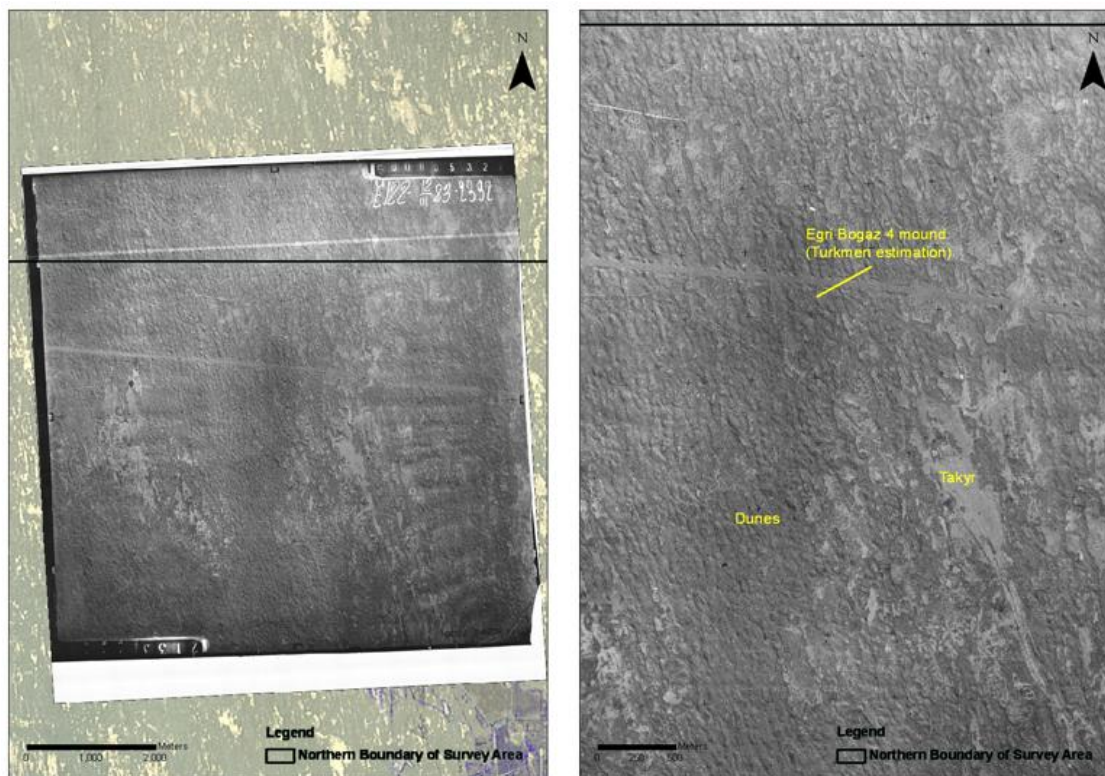


Figure 28. Aerial Photographs of the Egri Bogaz region. *Left:* Full aerial photograph with Egri Bogaz 4 in the centre. Note the striping on both the left and right of the image, and the darkening towards the edges. *Right:* Close-up of same area. Takyrs are visible as light greys due to their high reflectance. Agriculture is not evident here, although much of the takyr in the southeastern quarter of the image is now under heavy cultivation.

An overall assessment of the aerial photographs reveals an adequate visual representation of the key landforms within the survey area. The most clearly identifiable features, the unvegetated takyrs, are easily discerned by their high reflectance (greyscale values of over 190). The general trajectory of the dune ridges, typically orientated slightly to the west of due north, is clear, enhanced by shadow. Specific geomorphological boundaries, however, are difficult to identify in the photographs, and it was often difficult to assess where the specific boundary between, for example, an oversanded takyr and an adjacent dune ridge actually occurred. Although the AMMD researchers have highlighted the use of aerial photography in assisting the delta-wide survey (Cremaschi 1998), site identification derived solely from the aerial photographs appeared to be futile in the northern delta. Certain archaeological sites that occur within agricultural zones, such as Kelleli 3 and 4 and Egri Bogaz 1 (not shown), could be seen against the surrounding landscape, but this is due primarily to the fact that settlement mounds are often left unploughed, perhaps due to the intensive resources necessary to fully clear the mounds rather

than any legitimate concern for the integrity of archaeological sites. On uncultivated takyrs, known archaeological sites may be discernible when they occur in the middle of the feature as a result of the clear delineation between the high-reflectance takyr surface and the mixed sandy deposits that typify archaeological sites in the area. However, the visual signature of these features is very similar to similar deposits that occur throughout the Murghab, and can easily be confused with loose sands associated with anthropogenic activity or oversanding processes associated with takyr erosion (Fleskins *et al.* 2007). While some of the concentrations of material detected in the survey were associated with these soils, there was no obvious visual signature in the survey area that can offer strong evidence of a site on its own merit. The poor delineation of Egri Bogaz 4, comprising several hectares at the very least, offers a useful illustration of this difficulty. While it is possible to discern individual mounds, it is difficult to distinguish these from non-anthropogenic dune hillocks in the immediate vicinity. Better-defined visual signatures such as those at Gonur North or Adjı Kui 8 are absent in the northern delta, and these larger sites may owe their detectability in part to their size, contiguity, and relative lack of dune obstruction. Furthermore, it is probable that on some of the better-known sites, decades of excavations have enhanced spectral distinctiveness.

4.2.2. CORONA Imagery

The available CORONA imagery offered a comparatively low 14m spatial resolution compared to the CORONA imagery available in the Near East. It proved useful, however, in assessing broad changes in landscape development, particularly with respect to agriculture. A comparison of the CORONA imagery, acquired in 1964, to the recent ASTER and Quickbird imagery, acquired in 2001 and 2008 respectively, reveals a landscape only partially affected by anthropogenic activity, although the rapid agricultural development can easily be seen (Figure 29). Another useful application of the CORONA images was in the area of topographical comparison. Although small depressions and takyrs could not be detected at this resolution, comparisons between the CORONA imagery and other remote sensing imagery suggests that substantial geomorphological features—particularly stable dunes and large takyrs—have remained fairly stable. While such an observation may be obvious in terms of the underlying geology, the accumulation and deflation of aeolian deposits can severely alter topography over longer periods of time (Lioubimitseva 2003).

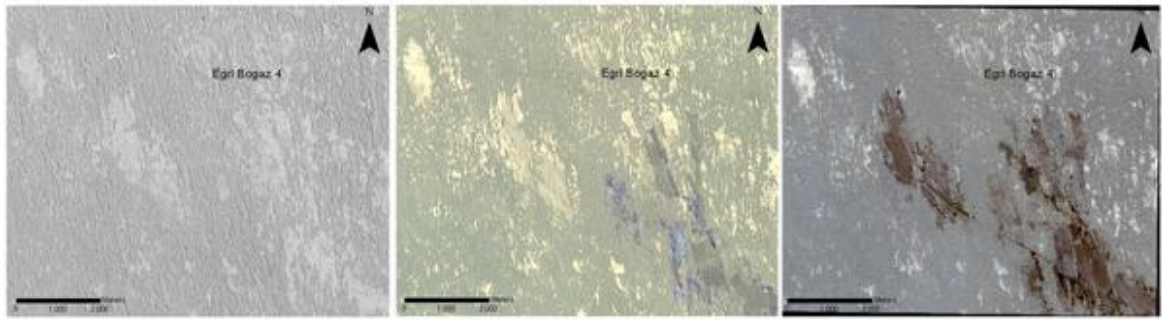


Figure 29. Agricultural encroachment in the northern delta: 1964-2008. *Left:* CORONA Imagery, 1964. *Centre:* ASTER VNIR imagery, 2000. *Right:* Quickbird Multispectral imagery, 2008

In terms of the potential for site prospection, the CORONA imagery—at least at the resolution available—did not prove to be an effective tool in the northern delta. Regions of moderate to heavy surface scatter did not present a significant visual signature in the CORONA imagery, and the complex surface environment of Egri Bogaz 4 offered little in the way of a distinctive archaeological signature. Clearly, the lower resolution of this imagery compared to that available in Syria and Anatolia, for example, was one reason for the poor detectability of sites. However, given the significant success of CORONA imagery elsewhere in detecting sites through crop-marks (e.g. Philip 2002), other factors must be considered. Beck (2007a) has demonstrated that CORONA signatures can be affected by variations in on-site drainage levels, and has been shown for several sites in the Homs region along the Orontes River in Syria. The lack of similar characteristics in the northern Murghab, while possibly partially attributable to the lower resolution, may also be explained by the obstruction of archaeological sites by sand. Another possibility is that anthropogenic activity may not have been intensive enough in these briefly occupied regions to leave an identifiable spectral signature on the landscape. Although the CORONA imagery therefore seems to be of limited use in the northern Murghab, it should be noted that imagery at 7-10m resolution has been used in conjunction with other remote sensing data to assist in site identification in the central delta. Indeed, some large sites can be seen in the CORONA imagery, although several of these, such as Gonur and Togolok, are easily discernible in most imagery and are thus unlikely to have been missed with even a cursory scan of the landscape.

4.2.3. QUICKBIRD Imagery

As noted above, the Quickbird imagery was obtained after the 2008 field season, so unfortunately was not available for the initial stages of the survey. As an analytical tool, however, its benefits were invaluable. Most apparent was the greatly improved spatial resolution, which made it much easier to visually examine the landscape. Clear examples of the improved resolution may be seen in the appearance of the main east-west road and gas pipeline which are clearly visible as distinct horizontal features, as are dozens of smaller roads and trackways throughout the survey area. Table 2 shows a comparison between the aerial photography and the panchromatic Quickbird imagery, both high-resolution greyscale images. In nearly all categories, the panchromatic imagery performed much more effectively in identifying specific topographic and anthropogenic features in the landscape, facilitated by a vastly superior image quality. A further advantage of the Quickbird imagery is its ability to distinguish subtle differences within similar land types. Recent aeolian cover, for example, tends to have a smooth, relatively uniform appearance, devoid of saxaul vegetation. Older, stable dunes, by contrast, tend to appear as undulating features, often pockmarked by small hillocks or depressions. On the takyr, the panchromatic imagery was especially effective in discerning subtle differences in moisture content. A recent study suggests that moisture and associated development of vegetation on the surface of an enclosed takyr will lead to a decrease in its surface reflectance (Orlovsky *et al.* 2004). The light grey shading on many of the takyr may therefore represent regions of slightly lower drainage, which may ultimately lead to an increase in vegetation and ultimately to the oversanding of the takyr. Figure 30 shows a comparative view of three takyr, one of which (top centre) appears to be well maintained, possibly in preparation for agricultural development. The association between the light grey takyr surface and encroaching vegetation can be clearly seen, both in the pan-chromatic as well as the lower resolution multispectral imagery (latter not shown).

Table 2. Comparison of Aerial Photography and Quickbird Imagery

	Aerial Photographs	QB (panchromatic)
Takyr	Visible as lighter grey tones, and discernible from surrounding dunes. Actual extent of takyr is not always discernible	Visible, highly reflectant. Delineation from Aeolian features is clear
Dunes	Individual dunes are difficult to pick out, north-south trajectory of landscape is clearer	Dune character is clear, enhanced by quantity of vegetation. Individual dune mounds can be identified
Depressions	Difficult to detect against topography	Clear, often appear as raised areas (visibility improves if image is inverted (Adams, Gillespie)
Cultivated Land	Grainy	Clear
Archaeological Features	Large depes in central delta often visible, small sites difficult to detect	Large depes can be detected, small sites may have a mixed spectral signature partially distinct from immediate surrounding landscape but difficult to discern over larger regions
Fluvial activity/palaeochannels	Often detectable	detectable

Another useful feature of the Quickbird imagery was its ability to offer an approximate indicator of topographic variability. Adams and Gillespie have noted that, even in the absence of DEMs or other topographic information, visual imagery may be used to assess approximate topographical variability in a landscape (Adams and Gillespie 2006: 8-13). Unfortunately, the late-morning acquisition time (around 11:00 am), meant that the shadows were approaching their lowest point and therefore the imagery was not ideal to clearly assess relative topography. However, clear delineations between small geomorphological landforms could be discerned. Because the eye is accustomed to visualising landscapes at ground level, it was necessary to invert the imagery—a common trick used by remote sensing analysts to counteract the unfamiliar visual angle (Adams and Gillespie 2006: 10).

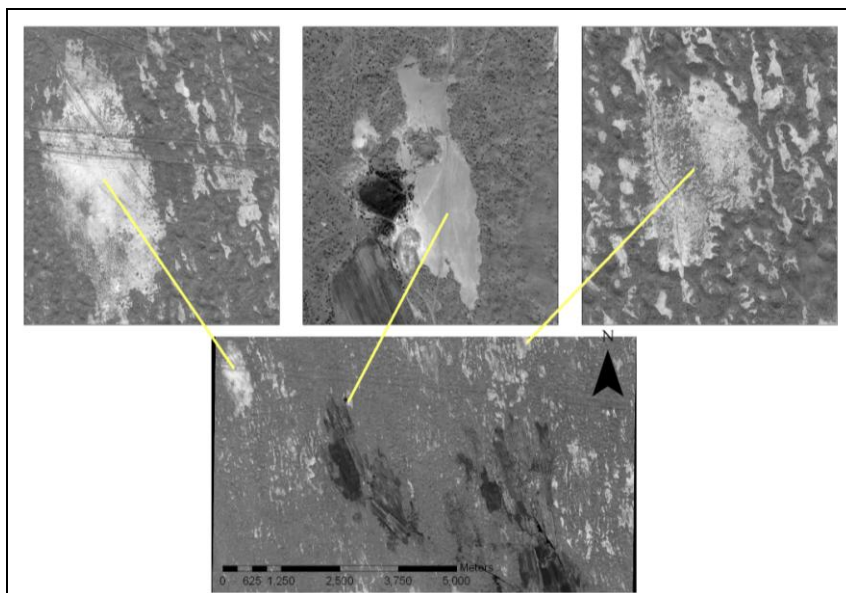


Figure 30. Takyr Surface Comparison (Quickbird Panchromatic Image)

4.2.4. ASTER Imagery

The multispectral ASTER imagery, at 15m spatial resolution for the VNIR bands and 30m for the SWIR bands (see section 3.5.1), was ideal for examining the general geomorphology of the entire northern Murghab, as well as some of the larger archaeological sites in the central delta. As with the other imagery, the most prominent geomorphological features were the larger unvegetated takyr, clearly visible in all bands. The high contrast of these features is due to their high albedo—a unitless measurement of reflectivity—across the spectrum.⁹ (L. Orlovsky, pers. comm.), While this identification was extremely useful for large takyr landforms, small ones below a few hundred square metres tend to be too small to be clearly discerned even at the 15m spatial resolution of the VNIR bands. Although some indicators of the underlying alluvial geomorphology loosely associated with the takyr could be discerned from the orientation of the surrounding dunes, it proved difficult to distinguish takyr from fluvial features at this resolution, and linear features identifiable in the ASTER imagery were re-examined in the Quickbird imagery to better understand the character of these landforms (see Marcolongo and Mozzi 1998; Lyapin 1991 on possible alluvial characteristics to the dunes.).

One noteworthy feature of the ASTER imagery was its ability to distinguish north-south linearity in the landscape. Although the resolution was too low to discern fine-scale topographical variation that could be seen in the aerial photography and Quickbird imagery, the ASTER imagery was the most effective in highlighting the dune topography in certain regions. In order to determine if the high detail of the Quickbird imagery was interfering with the ability to discern these broader patterns, the Quickbird image was resampled to 15m so that it could be compared directly with the ASTER VNIR bands. The resampling process used a cubic convolution method in order to provide a sharper rather than a smoother image (Reichenbach *et al.* 1995), which was potentially useful for identifying linear features. The results, shown in Figure 31, indicate that the linearity was still not detectable in the Quickbird imagery, and may be related to the reduced shadowing due to the time of acquisition (see above). The aerial photography showed the north-south patterning more clearly than the Quickbird imagery, so it is plausible that differences in satellite acquisition may be the primary cause of the discrepancy.

⁹Albedo is defined as the ratio of reflected light to incident EM radiation. It is essentially a unitless measurement of reflectivity between 0 and 1.

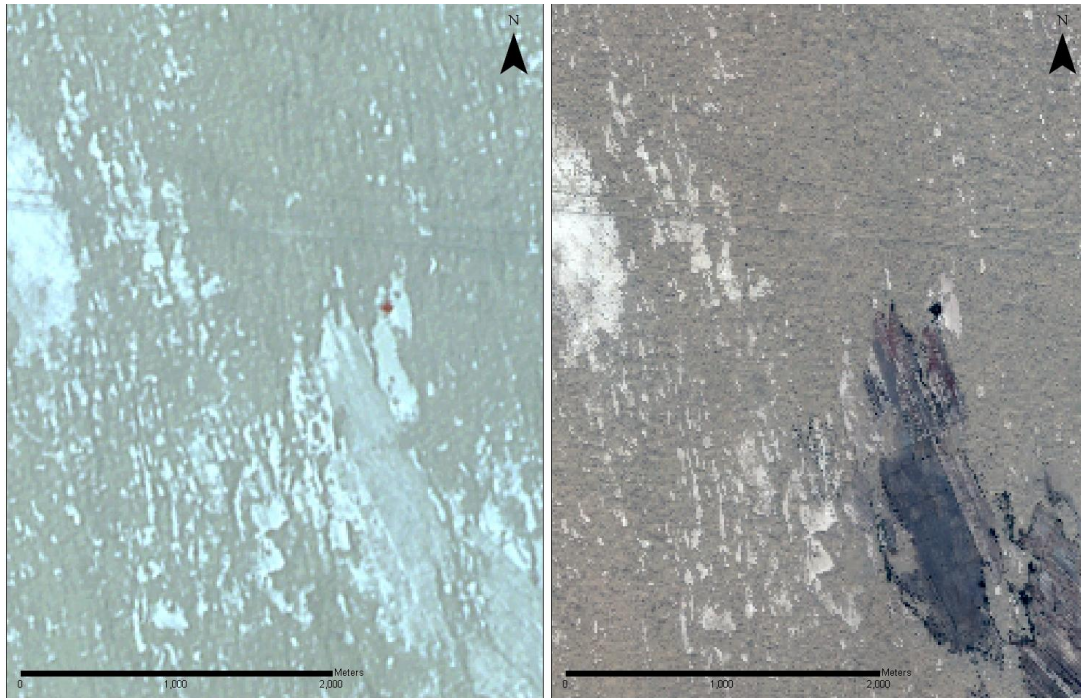


Figure 31. Comparison of linear features in ASTER and Quickbird. *Left:* ASTER 15m spatial resolution *Right:* Quickbird resampled to 15m spatial resolution The general NNW-SSE directionality is clearly discernible in the top half of the ASTER image.

The ability of the ASTER imagery to detect archaeological sites will be explored in more detail in section 4.5, but is briefly addressed here with respect to the general capabilities of the imagery. While many of the large, heavily excavated sites such as Gonur North, Togolok 1 and Adjı Kui 8 exhibited clear but varied signatures, Egri Bogaz 4 was not discernible on its own account. Spectrally, the site offers no distinguishing characteristics except a darker appearance with respect to the surrounding takyr. This suggests that the site itself occurs in a geomorphologically varied, but largely oversanded, environment, a finding that will be discussed in more detail below and in the following chapter.

4.2.5. ASTER/SRTM Digital Elevation Models

DEMs, primarily NASA's SRTM imagery, have been used effectively in the reconstruction of ancient fluvial patterns in Central Asia. For example, work in the Middle Zeravshan Valley in Uzbekistan has brought to light an extensive irrigation system consisting of both human-modified natural channels as well as canals (Mantellini *et al.* 2008). Research in this area,

however, has been facilitated by significant topographical variation as well as a comparatively unobstructed landscape. Parallel research in the Murghab, begun slightly earlier, has employed high resolution aerial photography, Soviet geological maps, and multispectral imagery to significant effect in the southern and central palaeodelta, and this work has resulted in a deeper understanding of channel use from antiquity (Cattani *et al.* 2008a; Cerasetti 2006). Considered an integral part of the AMMD research, this hydrographic reconstruction has been testable to some extent through the dating of materials along these channels, although the case in the north remains poorly understood.

Since the SRTM imagery has been so effective elsewhere in the delta, its applicability in the survey area was briefly assessed. As expected, the dendritic system of alluvial ridges could easily be traced within the modern delta, and the extension of a few significant branches could be traced slightly further (Figure 32). These branches are actually discernible by high rather than low DEM values, thus identifying the ancient river system by the raised topography associated with natural levees rather than any depressions associated with branches or channels. These altimetric variations became increasingly difficult to discern towards the northern Murghab, most likely due to the flattening of the topography towards the margin of the delta fan, and possibly exacerbated by the increasing complexity of dune formations in the same region. In the survey area itself, the main geomorphological features that could be discerned in the SRTM imagery were broad, cleared takyr associated with agricultural development, as well as a few large, low lying basins, although the altitude difference is generally no more than a few metres. Channels, either relict or associated with modern agriculture, were usually not detectable in the SRTM.

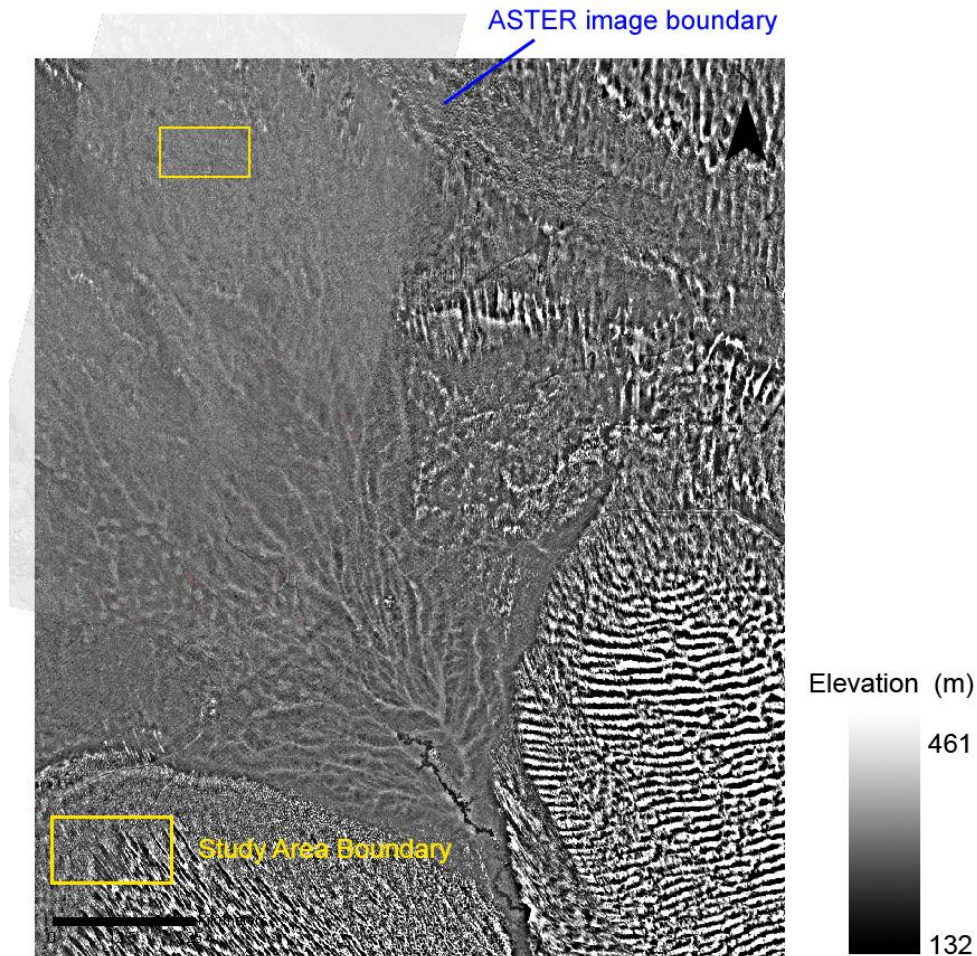


Figure 32. SRTM DEM of the Murghab delta. Note the decreasing prominence of the dendritic pattern further to the north. The main agricultural zones of the modern delta can be seen in dark grey in the ASTER imagery in the northwest of the image.

Whereas the SRTM imagery offers a 90m resolution, the 30m resolution of the ASTER product offered the potential to improve the topographical resolution of the study area (Figure 33). However, several difficulties were encountered in working with the ASTER DEM. The first was a significant degree of thick striping in the central portion of the image, in a roughly ENE-WSW direction. This kind of striping artefact can be caused by the collection methodology of the data, whereby similar values tend to autocorrelate along the direction of data acquisition. While less pronounced in immediate study area than further to the south, these artefacts impeded the interpretation of a landscape where actual topographical variation is minimal. Moreover, these artefacts may adversely affect more complex algorithms such as hydrological models (Albani and Klinkenberg 2009).

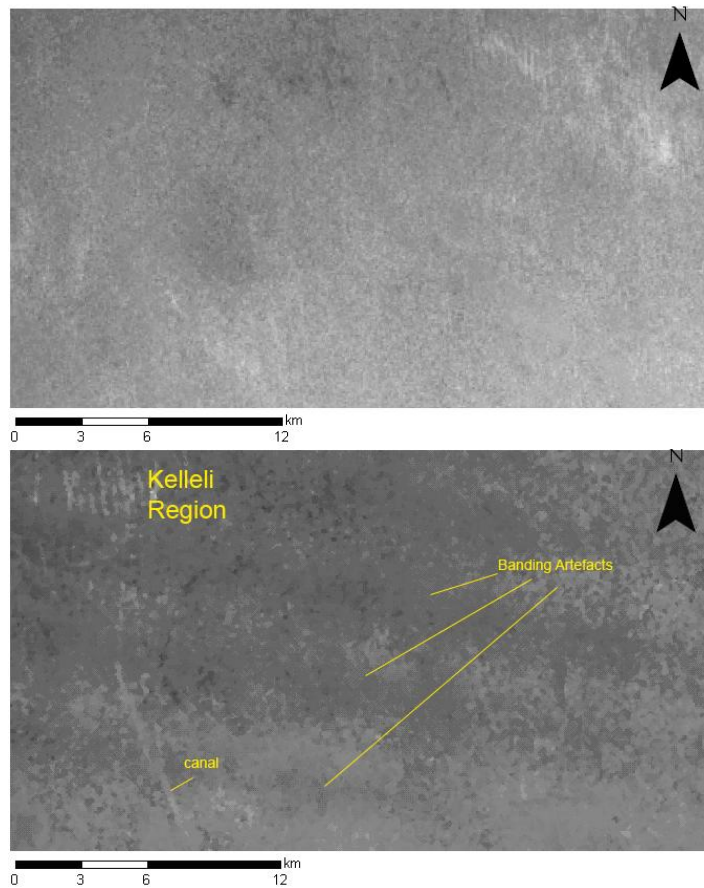


Figure 33. Comparison of SRTM and ASTER DEMs for the study region. *Top:* SRTM DEM (90m resolution) *Bottom:* ASTER DEM (30m resolution)

The ASTER DEM also proved difficult to interpret visually. The surface was highly variable, with elevations constantly fluctuating even over small distances. In order to maximise the potential for visual analysis, basic histogram stretches were applied, but these modifications were of minimal effect due to the extreme local variability of the landscape. The only easily identifiable features were related to modern agricultural practices. Large ploughed fields, often reflective of cleared takyr surfaces, were often visible, and in some cases field delineations themselves could be discerned, presumably as a result of upcast from small irrigation canals. Major irrigation canals, in the same vein, were often easy to detect. The most prominent agricultural zone identifiable on the DEM is the Kelleli region, which can be seen to open outwards from the large irrigation canal that runs parallel to the main ‘Kompressor’ road. The smaller agricultural region just south of the survey area may also be seen. Most geomorphological features such as dunes or takyr surfaces did not respond well to the visual assessment of the DEM. The failure of even large takyr surfaces to be detected as flat topographical regions may result from the lack of modern land clearance, and while variations in altitude as a result of sand

cover may only be a few dozen centimetres, such variations are significant in a region where the topographical variation is rarely more than 5m.

In order to compare both DEMs directly, and in an attempt to reduce the extreme surface roughness in the ASTER imagery, the ASTER DEM was resampled to 90m (as above) using a bilinear interpolation. Basic statistics for each image, shown in Table 3, indicate that the mean elevation was slightly higher for the ASTER imagery, although this appears to be partially explained by the presence of a concentrated area of elevations around 200m in the Kelleli region, an anomaly in the landscape. This feature does not appear to be solely an artefact of the DEM since it corresponds to a large uncultivated area of about 9ha, although the altimetric variation is far more subtle in the SRTM which indicates that the elevation values are probably not accurate. Standard deviation in the original ASTER DEM is significantly higher than in the SRTM, which indicates the higher sensitivity to spatial anomalies, although this discrepancy was reduced in the resampled image. One noteworthy observation is that canals and field boundaries were often clearly discernible in the ASTER DEM, but not the SRTM DEM. These differences between DEMs at the same spatial resolution suggest that while the overall distribution of data may be similar, there was a much greater surface sensitivity in the ASTER imagery associated with a high resolution of data acquisition, but likely including significant surface artefacts and a much higher potential for error.

Table 3. Comparison of ASTER and SRTM Digital Elevation Models

	SRTM	ASTER DEM (30m)	ASTER DEM (90m)	ASTER (3x3 Filter)
Max Elev (m)	189	147	151	155
Min Elev (m)	164	211	211	194
Mean Elev (m)	176.5	179	181	174
Std Dev	7.5	18.2	9.5	11.3

Both DEMs reveal that the topographical variation over the Bronze Age landscape is subtle, with most of the variation within about 10m. Significant topographical variation, at least at these analytical scales, occurs much further to the south. This uniformity can further be seen in a slope map (Figure 34), a derivative raster dataset that measures the maximum rate of change in elevation (by default, over a 3x3 cell neighbourhood). Slope measurements from the SRTM data did not exceed 2 degrees over the study area, and 2.3 degrees over the entire region comprising known Middle Bronze Age sites. By applying a stretched histogram, however, it became possible to detect subtle patterns in the slope map. Low values, in particular, tend to occur in regions of heavy agriculture. While this may seem obvious due to the levelling of fields for

ploughing, and in some cases even dune removal, it is also possible to detect meandering features, often linking these regions together. By examining these features in conjunction with the large takyr features, it became possible to gain a clearer notion of some aspects of the ancient fluvial patterns in the landscape. It is, moreover, not uncommon for modern irrigation canals to make use of the network of ancient channels, as the natural landscape in this region often largely determines where and how agriculture is practised. While it was not the aim of this research to reconstruct the northern Murghab palaeodelta, the SRTM data does offer a useful insight into the fluvial morphology of broad regions, as has been discussed elsewhere. With respect to the 140 km² study region itself, however, its effectiveness, as is that of the ASTER DEM, was extremely limited.

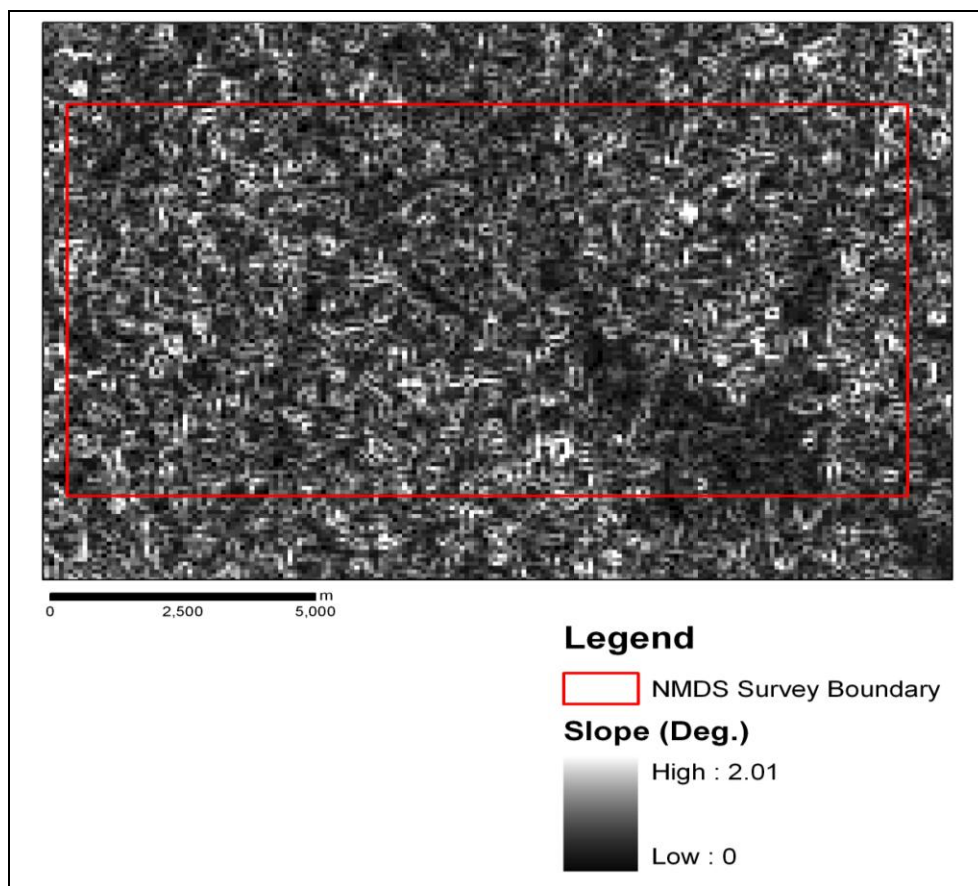


Figure 34. Slope map of NMDS survey area

4.3. Multispectral Analysis and the Northern Murghab Landscape

4.3.1. Basic Image Manipulation in ASTER

The original 3600 km² ASTER image represents a spectrally varied landscape, encompassing heavily mottled urban and agricultural features in the Mary and Bayramaly regions and a more uniform desert landscape in the north. This variability is problematic in image interpretation, since the colour table must account for all visible colours in the most optimal manner possible. Spectrally diverse urban environments, for example, may take up the vast majority of available colours (Adams and Gillespie 2006: 257-259). As a result, more uniform features in the desert landscape—namely dunes and takyr—yield very little visual differentiation. In order to alleviate this problem and enhance contrast within the survey area, several modifications were made. The first was simply to create a spatial subset of the study region. While simple, this change removed nearly all of the urban and much of the agricultural landscape, resulting in a much more diverse spectrum of the desert morphology in the northern delta. The resulting image was further refined by masking out the remaining agricultural zones in the landscape, resulting in an image that contained only sand dunes and takyr surfaces. With the full colour spectrum thus available to represent these two land types to a viewer on-screen, spectral contrast was greatly enhanced and subtle variations within seemingly uniform land types could be more easily discerned by eye.

A comparison of the 9 ASTER bands used in the analysis (Figure 35) shows significant distinctions between the VNIR bands (1-3) and the SWIR bands (4-9). The visible bands effectively resolve different geomorphological features, particularly delineating the boundaries between dunes and takyr, and some differentiation within takyr morphology can be determined. The region of oversanding on the takyr in the northwest of the survey area, for example, is apparent in all three bands as a mottling of white and grey pixels due to a mixture of both features. Subtle variations in the unobstructed takyr surfaces may also be identified, possibly due to slight differences in drainage. The SWIR bands, however, were much more effective in identifying changes in dune morphology. All SWIR bands, but especially bands 4 and 9, were able to identify two broad geomorphological regions in the southwestern portion of the survey area (areas 5-8). Lighter regions correspond to the low, rolling dunes that comprise much of the western portion of the survey area, while a prominent region of dark pixels, predominantly in

Area 8, is reflective of a much more varied dune environment. Similar spectral signatures occur in Area 2, and both regions exhibit a much more complex dune morphology, where sands were more loosely packed and blow-outs extremely common.

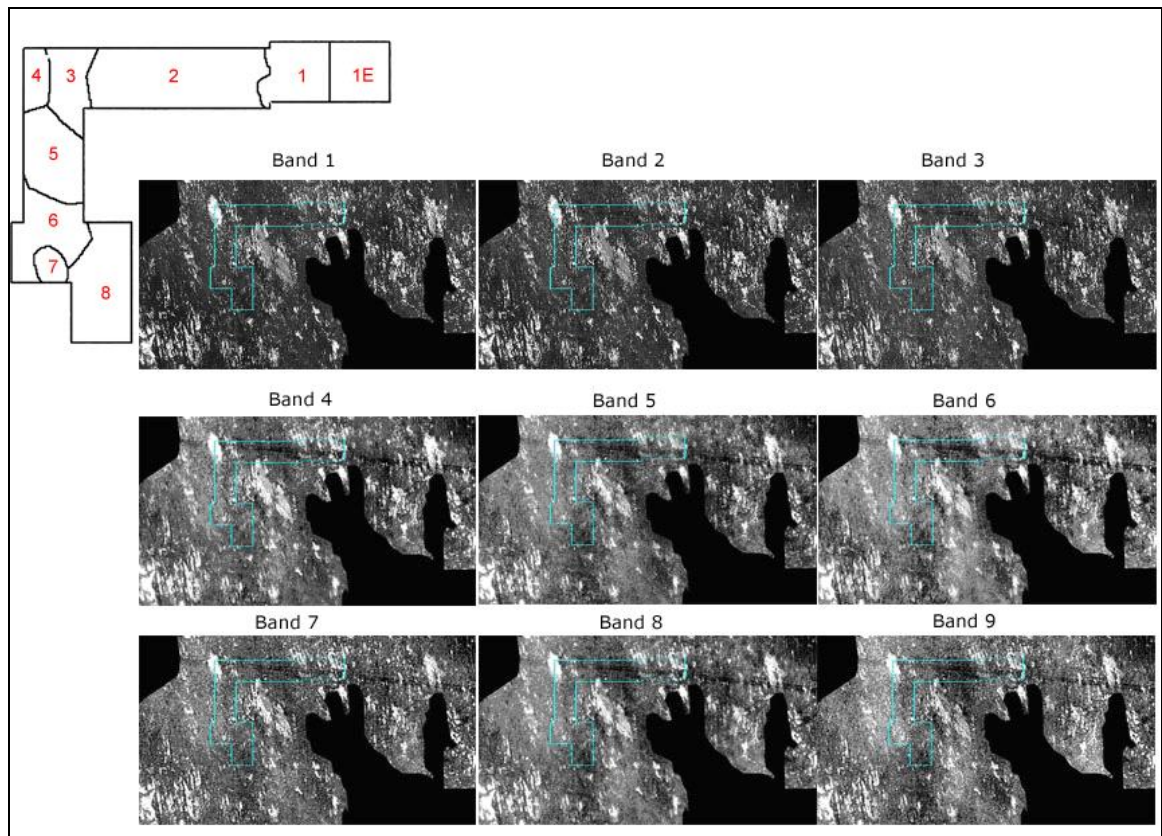


Figure 35. ASTER Bands 1-9. NMDS Survey Boundary is shown in blue, with corresponding analytical units indicated on the top left.

While a wealth of information may be obtained from each individual band, it is often useful to combine bands from both visible and non-visible spectra to present data from multiple bands in a single RGB image. By assigning specific bands or band combinations to the red, green and blue channels that comprise visible light, a single image can display a great deal of mineralogical or geological information in addition to what may be identifiable in the visual bands. In order to explore the optimum combinations for the survey area, the ASTER imagery was masked as per the above process, ultimately revealing only desert geomorphology. The dramatic improvements in contrast with the application of the mask can be seen in Figure 36.

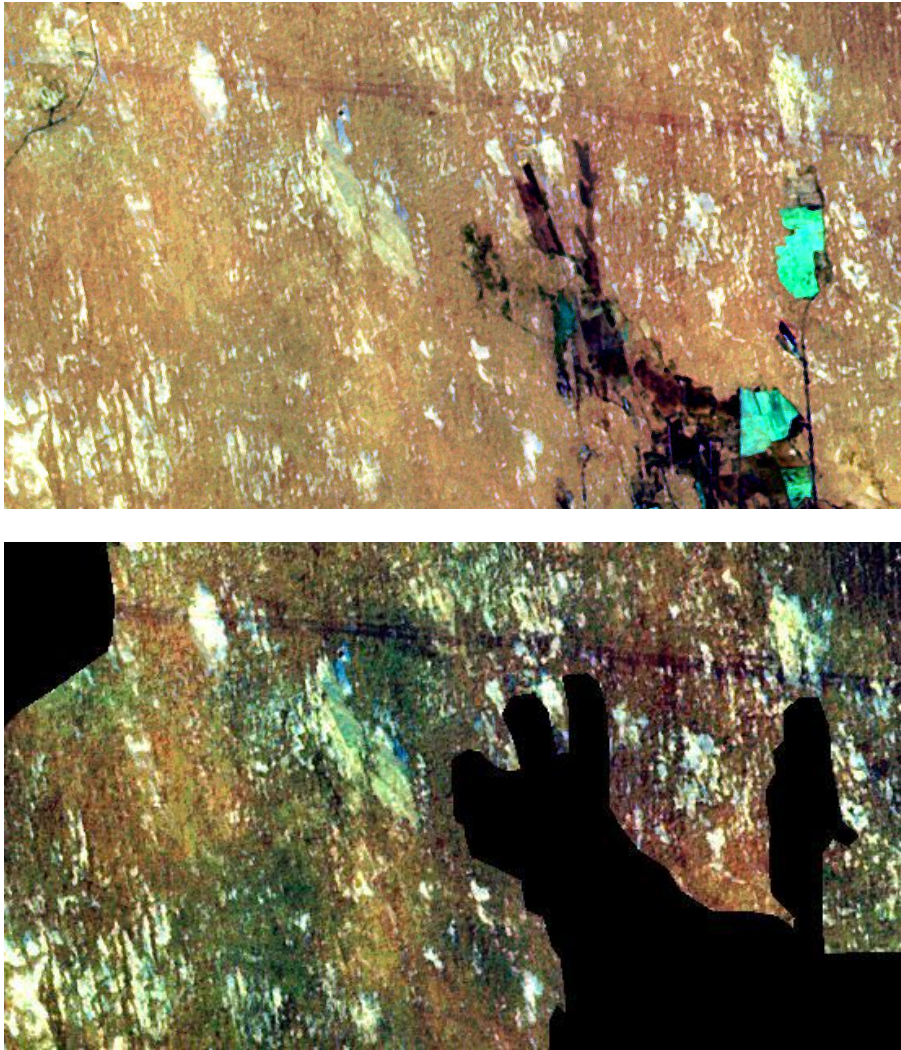


Figure 36. Effects of Agricultural Masking on multiband ASTER image. *Top:* ASTER 9-4-2 image without mask. *Bottom:* ASTER 9-4-2 image with major agricultural zones masked

Since the visible bands are highly correlated and therefore often present redundant data, the most useful band combinations were found to be those that contained two SWIR bands and a single VNIR band. Best results were achieved using either the 7-3-1 band combination which corresponds to the commonly used 7-4-2 Landsat combination used to identify geological changes in the landscape (Abdeen *et al.* 2001), or 9-3-1 which offered slightly better contrast. These combinations enhanced geological variability at the broad scale, while the inclusion of a high-resolution band could spatially refine the image, while presenting some additional information as well. Other image-enhancing methods, such as Brovey and Gram-Schmidt pan-sharpening algorithms (Karathanassi 2007), were found to be useful in terms of improving spatial resolution.

4.3.2. NDVI and Vegetation Cover

While a great deal of information can be gleaned from simple inspection of different bands, a slightly more complicated technique, the band ratio, has been shown to greatly improve contrast for selected materials. Band ratios refer to the ‘wavelength to wavelength’ ratio, obtained by dividing one band by another (e.g. a high-absorption band by a high-reflectance band) as a means of enhancing the spectral contrast (Adams and Gillespie 2006: 45-46). An additional benefit of this process is to reduce the effects of shadow, since this dark-pixel effect is present in all bands and is effectively minimised through division. Perhaps the most well-known band ratio is the Normalised Difference Vegetation Index (NDVI), which can be used to assess vegetation health. This index, given by the formula

Near IR-Red/NearIR+Red

makes use of the fact that chlorophyll present in heavy vegetation cover tends to reflect infrared (IR) light, while absorbing visible red light (Carlson and Ripley 1997; Curran 1983). The ratio between these two adjacent wavelengths is therefore larger in regions of healthy vegetation—high IR reflectance divided by low reflectance in the red band. The NDVI, however, is simply an automated index, and Adams and Gillespie (2006: 118) have cautioned against the blanket application of the NDVI ratio without regard for, or a comprehensive knowledge of, the region of application (also see treatment in Carlson and Ripley 1997). In poorly vegetated areas, for example, there may still be variations in the index caused by factors that have little or nothing to do with plant health at all. Figure 37 shows a comparison of the NDVI in both ASTER and Quickbird. In both images, bright values occur along canals, predominantly affected by dense vegetation in these regions. Beyond these irrigated zones, however, the index is ineffective in identifying vegetated zones, although the Quickbird NDVI, at a much higher resolution, does manage to pick out a few isolated pockets. However, the generally continuous, if sparse, saxaul cover throughout the survey area could not be detected. Similar results have been noted by Sepehry (2004), who has examined saxaul detectability in Landsat imagery through the use of several vegetation indices. Although he has found subtle visual distinctions, none of the commonly used vegetation indices was useful in providing a quantitative measure of saxaul landscapes.

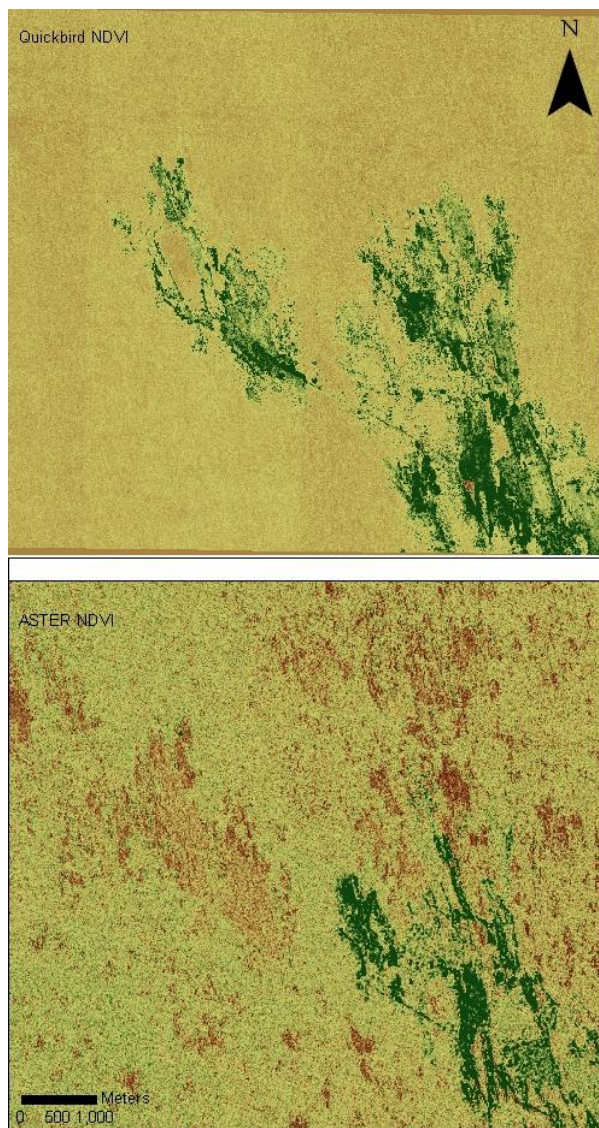


Figure 37. Comparison of NDVIs from Quickbird (*top*) and ASTER (*bottom*) imagery. Note the large area of healthy agriculture in the center of the Quickbird image. In the ASTER image, a canal can already be seen cutting through this region, so it appears that the bulk of agricultural development on this takyr was fairly recent.

Given the failure of the NDVI to produce a usable assessment of vegetation cover, a more direct method was explored, one that employed the visual detectability of individual saxaul bushes in the high-resolution Quickbird imagery. Individual saxaul shrubs are often visible in the panchromatic imagery, and while these tend to run together in the multispectral imagery, saxaul clumps can be easily detected. Standard classification algorithms are ineffective on a single-channel panchromatic image, so in order to incorporate both the high resolution panchromatic data and the multispectral data, the Gram-Schmidt pan-sharpening algorithm was selected. This method was chosen over the Brovey pan-sharpening algorithm since its implementation in ENVI

preserves all spectral bands, rather than reducing the pan-sharpened image to RGB. A vegetation training class or Region of Interest (ROI) was then specified by selecting pixels from discrete saxaul regions throughout the survey area. The Spectral Angle Mapper (SAM) algorithm was then applied with a threshold of 0.01 in order to select the vegetated regions. The SAM classifier measures the vector angle in N-dimensional space between the target pixel and the training class spectra. Because the angle, and not the vector length (brightness), is considered, the SAM classifier is less affected by shading and shadowing, and potentially suited for a better classification of an image where shading is present (Adams and Gillespie 2006: 96).

Results of the classification indicate that the method is useful as an automated way of determining a general degree of vegetation cover at a much higher resolution. A comparison of the panchromatic imagery and the classified image does, however, suggest that the classifier over-represented vegetation in the sanded or alluvial regions, and under-represented vegetation in the dry takyr zones. There are several factors that may have contributed to this result. On the takyr surfaces, the vegetation tends to be fairly sparse, and single bushes may simply escape detection. In regions of higher vegetation, the delineation between saxaul and shadow is often not discernible, and without an exact ground-truth measurement on several individual bushes (which may themselves be several metres off), there is no way of knowing the actual components of the pixels selected. The mean vegetation cover using this method was a scant 2.6% which, as indicated, was likely overestimated in regions of more variable sands and lower drainage. Figure 38 shows a box plot representing sherd counts over vegetation cover. No obvious relationship is evident, although there may be a slight increase in the middle vegetation ranges. Clearly, there is no indication that saxaul cover had any impact on sherd counts, and it is unlikely that the sparse desert scrub would have had any measurable impact on visibility. The method may, however, be more useful in spring surveys where vegetation cover is significantly higher. Such an improvement may also be true of the NDVI, although further research is needed to test these possibilities.

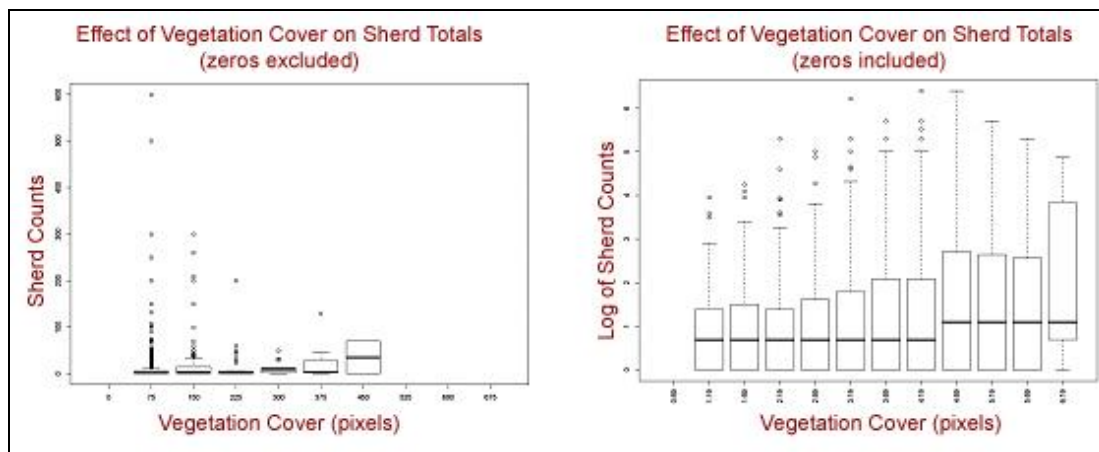


Figure 38. Relationship between sherd totals and estimated vegetation cover. *Left:* Zero sherd counts have been excluded to reduce the skew. *Right:* Logged relationship between the variables. With the exception of a possible increase towards the mid-level vegetation cover, no relationship is readily apparent.

4.3.3. Principal Components Analysis

The initial assessment of the bands in section 4.3.1 showed that certain bands, typically those with similar wavelengths, tend to be highly correlated. The resulting spectral redundancy can make it more difficult to extract pertinent information. A common way of dealing with this problem is through the use of Principal Components Analysis (PCA), a technique by which a set of correlated variables—in this case spectral bands—are transformed to a set of orthogonal axes, thereby creating a new set of uncorrelated variables (Byrne 1980). The first principal component (PC) accounts for the greatest variance in the image, the second PC accounts for the maximum variance not accounted for by the first PC, and so on. Ultimately, the vast majority of variance can usually be accounted for with only a few PC bands, effectively condensing relevant information into a small number of bands.

The purpose of the PCA analysis was two-fold: to assess its usefulness in interpreting the landscape, and to examine the degree to which it may be useful in highlighting settlement locations in the survey area. The first analysis used ASTER bands 1-9, and was conducted over the entire region, after using the NDVI (threshold 0.02) to isolate and mask out broad agricultural areas. Of the 9 principal components generated, only bands 1-4 were useful, as the rest were too noisy to offer any interpretative assistance. PC 1 roughly approximates a visual image. Basic landscape features are evident, and the delineation between bare and over-sanded

takyr is clear. Trackways appear to be enhanced in the image, as evidenced primarily by the clarity of the road and pipeline. PCs 2 and 3 are not particularly useful in deconstructing the general dune cover of the study area. Discrepancies in the takyr composition, however, are much more clearly defined than in Band 1. Again, the large takyr in Area 4 offers a useful analytical region. An RGB composite using PCA bands 4-3-2 clearly revealed the over-sanded portion in the southwest, along with a bright area of red along the eastern perimeter of the takyr, corresponding to Band 4. It is worth noting that high PCA 4 values are also associated with the large, vegetated depression in Area 2, as well as the entire eastern edge of this takyr.

A second PCA evaluation incorporated both Quickbird and ASTER bands by creating a stacked image, replacing the first three ASTER bands with the four corresponding Quickbird bands in order to make use of Quickbird's higher resolution. The main agricultural zone was fully masked, although the large, partially cultivated takyr extending south from Area 2 was included in the analysis. PC 1, as in the ASTER PCA, effectively identified key geomorphological features, distinguishing clearly between sanded and takyr regions, although discrepancy within dune regions are not easily discernible (Figure 39). The dune ridges are much clearer in PC 2, and these were further enhanced by employing PC band combinations of 1-2-4 or 4-2-1. These linear features, represented by light green tones, can be seen on either side of Egri Bogaz. Similar spectral features occur in conjunction with the major road and pipelines, and to a lesser extent to the older road to the north. Interestingly, this degree of dune concentration does not appear to feature prominently in the southern portion of the survey area. A boundary can be traced southward from the eastern perimeter of the takyr in Area 4. The relationship between high-density sherd scatters and the obstructed/eroded takyr surface, indicated by the purplish but heavily mottled regions, is evident, most likely reflecting the eroded material onto the takyr surface (discussed further in section 7.4).

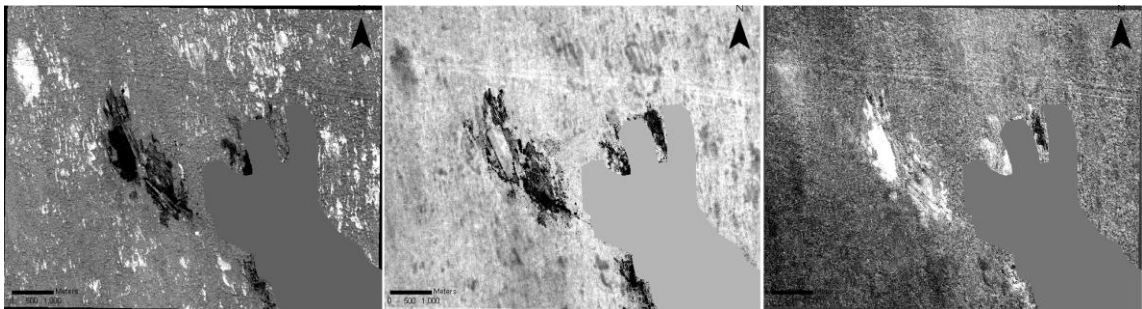


Figure 39. PCA Bands 1, 2 and 4, respectively. Note the clarity of the dune topography in PCA2 in the middle image (lighter N-S or NNW-SSE banding).

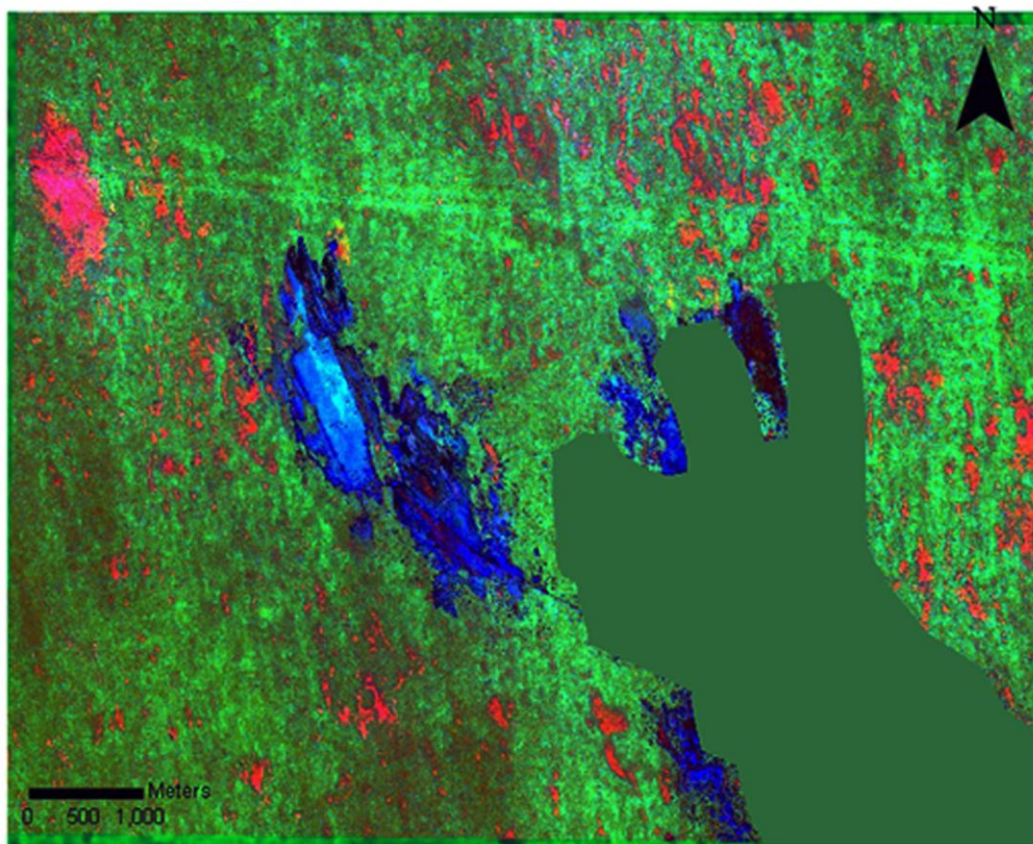


Figure 40. Composite image of PCA bands 1-2-4. Dune topography is very clear in light blue/green, corresponding to Band 2.

In order to explore the possibility of detecting archaeological sites, an assessment of the visibility of known Middle and Late Bronze Age settlement mounds was evaluated against the first four PC bands from the ASTER imagery. The full results are shown in Table 4. Most of the known archaeological sites are visible in PC1 as light grey regions, and typically appear lighter than the surrounding landscape. Site discernibility is significantly reduced in PC2 and PC3, although large sites are often still visible. The high factor loadings of VNIR bands in PC1 suggest that, for the most part, the discernibility of sites is determined primarily by the visible spectrum. This does not, however, preclude some contribution from the SWIR channels, which may be more likely to be enhanced by the spectral signatures of clays in decaying mud-brick. In the northern delta, the PCA analysis did not sufficiently enhance site detection. While the larger sites of Egri Bogaz 1 and 2 as well as Kelleli 3 and 4 could be detected, this was primarily due to the high contrast against the ploughed fields which could be detected visually.

Table 4. PCA Discernibility of Selected Middle and Late Bronze Age Sites

Site No	Name	PCA1	PCA2	PCA3	PCA4
170	Gonor 3	very light grey area slightly s. of where vector is defined	Dark grey, less clear than PC1	medium grey, may not be the actual site as much as the surrounding landscape to the east	Poorly visible
171	Kel 3	region is slightly darker grey from surrounding talgr, which is white - heavy vegetation appears dark	Unlikely against the vector, but a similar dark grey as the agricultural fields. Kel 4 is lighter	medium grey, may not be the actual site as much as the surrounding landscape to the east	Poorly visible
172	Kel 4	region is slightly defined - but surrounded by agriculture	Same as Kel 3	Same as Kel 3 (MAY be field directly to the east shows up darker than rest of field - perhaps worth checking)	Poorly visible
173	Kel 5	Same as Kel 3	not clearly visible	two dark grey areas, clearly visible	poorly visible
174	Talp 1	very light 2 mounds crossed by canal	not clearly visible	two dark grey areas, clearly visible	poorly visible
175	Talp 2	very light, clearly visible	appears as medium grey	poorly visible	poorly visible
182	Topolok 1 (in part)	very light, clearly visible	appears as medium grey	poorly visible	poorly visible
182	Topolok 1	not clear in any PC			
236	Egri Bo 1	clearly visible, bright - appears slightly south of where vector is drawn but partially contained within v	small black region - contiguous with brightest part of PC1	medium and dark, grey - outline roughly contiguous w/vector (but shifted slightly south, again) may be discernible	
236	EB2	clearly visible - bright	clearly visible - med. Grey	clearly visible - dark grey	
236	EB3	not vis.	white area contiguous w/vector	not clear	
236	EB4	unclear - possible light grey spots within dunes may reflect signature	med. Grey	not clear	
393	Adam B 4 East	as usual - lighter and identifiable	med. Grey	dark grey	
404	AB5	only really visible in PC1 - and not clearly aligned with vector - may not be able to pick it out of a landscape	not clear	same as PC2	
406	Talp 3	clearly visible as light grey against surrounding white talgr	shows up as med. Greys, against dark greys of talgr	med-dark grey	
409	ak3	clearest in PC1 - standard off-white	possible med. Grey, not clearly identifiable	dark grey, but not obvious	
412	ak2,4	light grey blob in v. part of vector - med. Grey throughout the rest	med. Grey contiguous with light part in PC1 - rest is unclear	Dark grey, contig. with PC1	
413	ak2,4	light grey in v. part of vector, faintly discernible from surroundings	not clear	possible slightly darker, but extremely faint	
421		bright, clearly visible	med Grey - not very different from surroundings, but surrounded by dark ring (see Kel 4)	dark region	
422		these sites aren't obvious, although 422 and 423 show the brighter levels in PC 1			
423					
424		not clearly obvious by shape, although it does cover some of the brighter regions	not readily discernible from rest of landscape	not clearly visible	
430		clearly visible, light	not clearly visible	faintly visible - darker grey against med. Grey landscape	
431		clearly visible, light	not clear	some that disemble - runs into canal	
433		very faint - slightly lighter in parts	not clear	not clear	
656	Austin	very clear and light	shape discernible, but blends into landscape	clear - dark grey	
709		not clear	not clear	not clear	
715		not distinguishable from landscape	same	same	
717		not clear	not clear	not clear	
718		not clear	not clear	not clear	
723		not distinguishable from landscape	not distinguishable	not distinguishable	
724		not discernible as specific tepe, but region is the same lighter color	not clear	not clear	
725		same as above	not clear	not clear	
726		not clear	not clear	not clear	
730		not clear	not clear	not clearly visible	
731		not clear	not clear	not clearly visible	
731		not clear	not clear	not clearly visible	
742		not clear	not clear	not clearly visible	
742		est. of 288	not clear, but POSSIBLY reveals a perimeter	slightly darker grey	
753		very faint, but lighter than surrounding landscape	not clear	not clear	
956		not clear	not clear	not clear	
957		falls on area of very light greys, so possibly visible	not clear	not clear	
958		clearly visible - bright	not clear	not clear	
959		clearly visible - bright	not clear	not clear	
960		clearly visible - bright	not clear	not clear	
961		clearly visible - bright	not clear	not clear	
962		clearly visible - bright	not clear	not clear	
963		clearly visible - bright	not clear	not clear	
964		clearly visible - bright	not clear	not clear	
965		clearly visible - bright	not clear	not clear	
966		clearly visible - bright	not clear	not clear	
967		clearly visible - bright	not clear	not clear	
968		clearly visible - bright	not clear	not clear	
969		clearly visible - bright	not clear	not clear	
970		clearly visible - bright	not clear	not clear	
971		clearly visible - bright	not clear	not clear	
972		clearly visible - bright	not clear	not clear	
973		clearly visible - bright	not clear	not clear	
974		clearly visible - bright	not clear	not clear	
975		clearly visible - bright	not clear	not clear	
976		clearly visible - bright	not clear	not clear	
977		clearly visible - bright	not clear	not clear	
978		clearly visible - bright	not clear	not clear	
979		clearly visible - bright	not clear	not clear	
980		clearly visible - bright	not clear	not clear	
981		clearly visible - bright	not clear	not clear	
982		clearly visible - bright	not clear	not clear	
983		clearly visible - bright	not clear	not clear	
984		clearly visible - bright	not clear	not clear	
985		clearly visible - bright	not clear	not clear	
986		clearly visible - bright	not clear	not clear	
987		clearly visible - bright	not clear	not clear	
988		clearly visible - bright	not clear	not clear	
989		clearly visible - bright	not clear	not clear	
990		clearly visible - bright	not clear	not clear	
991		clearly visible - bright	not clear	not clear	
992		clearly visible - bright	not clear	not clear	
993		clearly visible - bright	not clear	not clear	
994		clearly visible - bright	not clear	not clear	
995		clearly visible - bright	not clear	not clear	
996		clearly visible - bright	not clear	not clear	
997		clearly visible - bright	not clear	not clear	
998		clearly visible - bright	not clear	not clear	
999		clearly visible - bright	not clear	not clear	
1000	Gonor 5	very clear in shape - light - surrounded by grey concentric square	med. Grey	dark Grey	
1003	Gonor N	best in this band, but visible in all			
1008	Gonor area no 1	very light, grey area slightly s. of where vector is defined	Darker, gray, less clear than PC 1	Poorly visible	

4.4. Classification and Visibility Potential

The visibility problem in the Murghab delta, as noted in earlier chapters, is well recognised (Cattani and Salvatori 2008). However, attempts to quantify the problem have been lacking (see section 2.6). Instead, visibility in the Murghab is usually treated as binary, where sand cover is seen to obscure material that would otherwise be visible on the exposed alluvial surface. The lack of material in the north is therefore seen largely as the result of dune cover (e.g. Cattani *et al.* 2008a: 42).

4.4.1. Large-Scale Assessment of Land Type and Site Visibility

To examine the effects of variable land cover on recovery potential, it was necessary to develop a standard method of quantifying the land types over the survey area. In many surveys, this is done visually, where an observer classifies a given area according to perceived land type, vegetation cover, or some other determinant of visibility (Bintliff and Snodgrass 1985; Van Leusen 2002: 4-12). While this was initially attempted for the NMDS survey it was found to be ineffective due to the extreme variability of the landscape at small scales, and was therefore subject to significant observer bias (see Chapter 3). Classification algorithms, commonly employed in remote sensing technology, offered a way of statistically categorising large land areas that effectively removed this bias, providing an alternative (and more systematic) bird's eye model of a landscape not accessible to people in the field. Classification may be divided into unsupervised and supervised algorithms. In unsupervised classifications, a set number of classes is determined in advance, and image pixels are assigned to a particular class based on the selected statistical algorithm. Supervised classifications, by contrast, allow the researcher to specify particular training sites (Parcak 2009: 94-96). Ideally, these should be regions of limited spectral variability that have been previously identified via ground truthing (Adams and Gillespie 2006: 99-102). While this latter method does reintroduce an element of observer bias in the selection of the training sites, it facilitates the inclusion of actual knowledge of a landscape that would otherwise be missing, and can thus provide a more accurate interpretation of the image.

In keeping with the concept of scale, the classification analysis was conducted using a top-down approach to the categorisation of the landscape. The largest scale of analysis, covering the entire survey area, sought to address the relative paucity of sites over a fairly large area, and the degree

to which the visibility restrictions of the northern Murghab may have contributed to this perceived lack of occupation. As noted earlier (section 1.4), the low number of known sites in this region stands in stark contrast to the relatively site-rich environment in the central delta. While intensive geomorphological study has not focused specifically on the northern delta, a simple test of landscape variability was used to compare the survey area to the larger region of Middle Bronze settlement. First, a convex hull polygon was constructed that contained all currently known Middle Bronze Age sites. Then, major agricultural zones identifiable in the ASTER imagery were masked out. A supervised classification was run using easily identifiable land types as training classes. The results, shown in Table 5, indicate that general distributions within the uncultivated landscape in the 140 km² study area were not significantly more restrictive than in the Bronze Age delta in general. Furthermore, open and oversanded takyr, which researchers suggest show the clearest evidence of archaeological sites, are actually more prevalent in the study area. This may be attributable to the increase in exposed clayey basins towards the distal portion of the alluvial fan. Stable dune cover is slightly lower in the study area, at 69.2% compared to 72.1% for the entire area. While this test is extremely general in terms of the complex geomorphology in the region, it offers a general perspective on relative visibility and prospects for site recovery. Since the survey area actually reveals less sand cover than does the entire region, it is a reasonable assumption that visibility due to land cover variation alone is probably not sufficient to explain the apparent lack of settlement in this region, and other factors will be explored below.

Table 5. Land Cover Percentage (Non-Agricultural) Based on ENVI Supervised Classification

Land Type	140 km Study Area	MB Region (defined by Convex Hull polygon including all known MB sites)
Open Taky (little or no oversanding or vegetation)	2.6	2.09
Oversanded/Obstructed Taky	16.1	11.12
Stable Dunes	41.5	38.2
Variable Dunes (slightly higher vegetation density)	27.7	33.9
Active Dunes	11.1	13.4
Site+	0.2	0.2
Cropland++	0.4	0.6

+Based on the training site of AKF 3 (see below) selected because of its clear visual identification and spectral contiguity

++Small percentage of cropland that was not masked by the algorithm. This category never rises above 1% and is insignificant to the analysis.

In order to broadly assess the relationship between land cover and Bronze Age settlement, a similar test was conducted on all Bronze Age sites detected by previous Murghab surveys. Using an unsupervised classification the Bronze Age region was divided into 8 land categories. To prioritise the dominant land use features in this landscape and exclude single cell identifications, a 3x3 low-pass majority filter was then used. Sites were designated as the centroid of the corresponding AMMD polygon. A chi-squared test of sites in each land category yielded a value of 33.2 at 7 degrees of freedom, suggesting a significant pattern in terms of the kinds of landscapes in which sites appeared. Land categories that corresponded to vegetation and open takyr had values that were too small to be significant. The highest chi square value for a single category was for the sandy-takyr layer within an overall pattern that was very significant ($p < 0.001$). There are several potential reasons for this predominance of sites in the sandy-takyr layer, pertaining to archaeological visibility rather than initial settlement pattern. The most obvious is the fact that dune areas were less thoroughly surveyed, and probably obscured many small sites. There is also a bias in the classification—the unsupervised 8-class classification is only a rough approximation of the actual landscape, so the delineation between sand and takyr is only representative. The significance of oversanded takyrs in terms of material distribution is discussed in more detail below, as well as in section 7.2.

4.4.2. Visibility in the Survey Area

Selection of Training Sites

For the visibility analysis of the survey area itself, it was necessary to select a new group of training sites that were more reflective of a localised area. The selection of these training areas, or Regions of Interest (ROIs), was facilitated both by the excellent resolution of the Quickbird panchromatic imagery, and the fact that all areas had been surveyed at the time of the analysis. The familiarity with the landscape acquired from two years of survey afforded a much clearer understanding of the relationship between the remote sensing data and actual land cover that was the broader regional study could not provide. Furthermore, the fact that the imagery was acquired at the time of the survey allowed image data to be directly associated with ground observations. Based on field observations, eight training classes were initially selected for analysis (Table 6). An image stack was then created, replacing the high resolution ASTER bands 1-3 with Quickbird bands 1-4 (see section 4.3.3). This procedure allowed the high resolution visible bands to be evaluated simultaneously with the lower resolution SWIR bands. While this manipulation is not recommended for more advanced spectroscopic analysis due in

part to issues of calibration (R Harris, pers. comm.), it was extremely effective in the more general classification algorithms employed in this analysis.

Table 6. Description of Regions of Interest (ROIs)

Land Type	Comments
Dry/Open Takyr	Open takyr, little or no vegetation
Sanded Takyr	Typically on perimeter of takyrs, shallow aeolian deposits characterised by light saxaul vegetation. May result from takyr erosion.
Moist Takyr	Slightly darker soil profile, generally softer and more friable subsurface texture.
Variable Dunes	Pertains to an uneven dune landscape. Typically these may be interspersed with small depressions, takyrs and blow-outs Occasional, randomly distributed active dunes and shell cover occur.
Agricultural Dunes	Sand cover associated with agricultural regions
Stable Dunes	Sampled from Grids D/E.
Road	Sampled from along the east-west road south of the pipeline
Egri Bogaz 4	Incorporates a small section of the elevated area of Egri Bogaz 4 and areas of high-density material

In order to identify effective training sites, an ROI separability index (the Jeffries-Matsuhita distance) was calculated for each region. While some variability is to be expected within each training site, ideal sites should be relatively uniform and spectrally distinct from other classes, with ideal separations around 1.8 or higher (Arroyo-Mora *et al.* 2009). The resulting ROI separability was excellent, at 1.9 between all classes except for Moist Takyr and Sanded Takyr, which generated a slightly less-than-ideal value of 1.74. A separate training class covering the Egri Bogaz 4 settlement region was initially included in order to examine the effect of including a known site in the classification. However, even after several attempts at finding an ideal training area representative of the site, separability was very low, particularly from dune features, and the class was ultimately rejected for the analysis. The poor discernibility of Egri Bogaz 4 as a distinct spectral region was most likely attributable to the highly variable land cover in the area, alternating between uneven sand cover and exposed alluvium even over very small distances.

Classification was run on the stacked image, and a mask was applied by digitising the approximate area of vegetation and removing this from the classification. Although masking can be a complex procedure (Kastens 2005), the agricultural fields were not central to the analysis, and the removal of some dunes and takyrs in the vicinity of the fields did not pose a significant problem. Additional masks were tested that relied on the extraction of vegetation based on the

NDVI index, but these were found to miss many pixels in agricultural zones and could have negatively affected the classification. Figure 41 shows the results of the classification. Although the classes are broad and only meant to represent general land categories, several trends may be seen. The classification clearly highlights the distinct dichotomy between the stable dunes that dominate much of the western portion of the survey area and the variable dunes found primarily in areas 2 and 8. Interestingly, this stable dune category appears to be nearly absent in much of the eastern portion of the image. The significant distance (at least a kilometre) between these semi-stable dune regions and the agricultural fields suggests that the loose deposits associated with agricultural activities have not impacted this portion of the landscape, although the field survey did indicate several areas of recent windblown sands in these regions as well. Another factor worth considering is the effect of fluvial activity in antiquity as well as more recent drainage. It is possible that the prevalence of complex channel activity evidenced in the takyr region around Egri Bogaz 4 has contributed to a more complex dune topography (also see section 7.7).

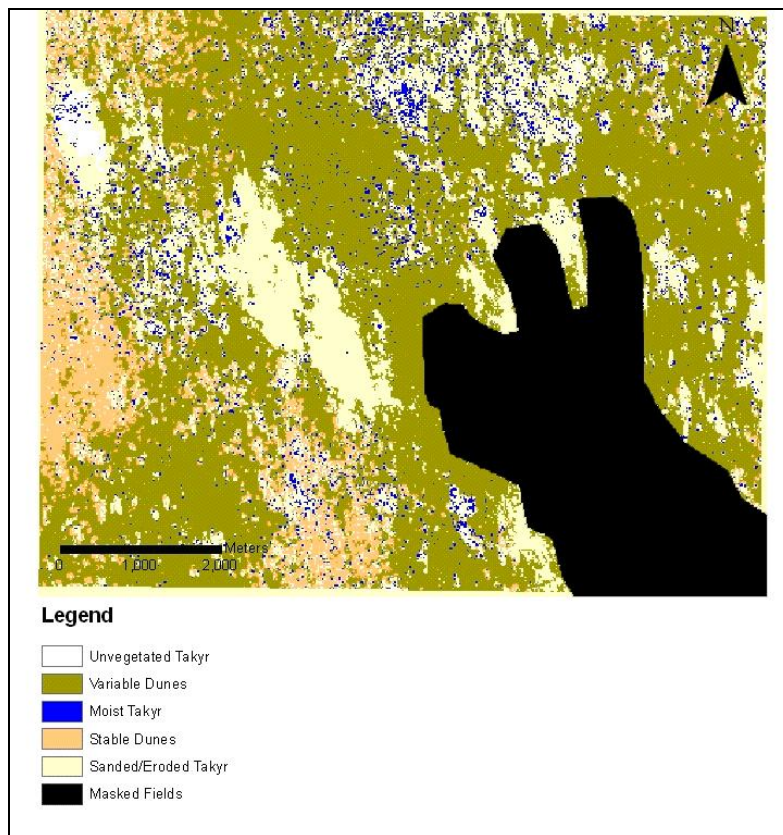


Figure 41. 5-Class Supervised Classification of ASTER/Quickbird Bands

A comparison of the stacked image with a supervised classification of only the Quickbird imagery indicated that the latter was much less effective in discerning between the broad dune categories. Although the small sandy depressions, typically barely covering the alluvium, were more detectable using the high resolution imagery, the character of the dunescapes in the southern portion of the survey area appear more uniform than in the ASTER imagery. This suggests that much of the spectral variation is derived from the SWIR bands. Support for this possibility may be seen by spectral signatures in ASTER Bands 4 and 9, which quite clearly reveal this dichotomy in the dune regions (see section 4.3). The implications of such classification algorithms will be examined at a much finer scale with respect to the specific distribution of material in the following chapter.

4.5. Remote Sensing and Site Identification

Although remote sensing data has been employed since the mid-1990s as an aid to site prospection in the Murghab (see above), its use in this endeavour has been largely unsystematic. Elsewhere, more systematic approaches to site prospection have met with mixed results. Topographical identification of large tells in the Khabur region in northern Syria has been largely successful—but only in cases where the elevation differs significantly from the background topography (Ur *et al.* 2006). Small sites, however, have typically eluded detection. With respect to visual or multispectral imagery, high resolution CORONA and IKONOS imagery have been fairly successful in western Syria, due in part to varied reflectances caused by differential drainages (Beck *et al.* 2007a). Menze notes that well-drained, loessy soils and decayed mud-brick that comprise the surface of tells can, in many cases, be easily identified. The potential benefits of multispectral imagery in site identification, however, have only recently been addressed. Some of the most promising results have been seen in the Khabur, where multispectral classification of several coterminous ASTER granules correctly classified nearly 70% of training sites over a 5400 km² test area (Menze and Ur 2007). Additionally, Lasaponara and Masini (2006) have explored the multispectral capabilities of Quickbird, particularly with respect to vegetation detection, finding that the Quickbird sensors were especially adept at detecting cropmark variations in vegetated or agricultural zones.

4.5.1. DEMS and Site Prospection

The examination of remote sensing data for site prospection in the northern Murghab relied on a general assessment both of DEM and multispectral data. The analysis was subject to several initial limitations that must be noted here. First, the datasets were quite restrictive. The Quickbird imagery only covered a small portion of the Bronze Age settlement region, where known settlement mounds were scarce, so it could not be used effectively for comparison with large known sites. Another significant problem was how to determine what constituted the boundary of a site. This was less of an issue in the DEM assessment, where the mere knowledge of the presence of a mound was sufficient for the analysis. In the multispectral imagery, however, the selection of training regions where discrete spectral characteristics indicative of anthropogenic mounds could be identified was a highly subjective process, and it proved necessary to define entirely new boundaries rather than rely on the existing boundaries of the sites defined in earlier surveys.

The complexity of the landscape, and the difficulty in identifying topographical variations even in features that were visually prominent, such as takyr, suggested that prospects for the identification of settlement mounds in this landscape could be poor. While DEMs, primarily the 90m SRTM, have been used in the context of archaeological prospection in the Murghab, the primary focus has been on geomorphology, with a secondary emphasis on visual modelling and presentation. The systematic ‘tell-spotting’ algorithms employed in northern Mesopotamia and Anatolia (Menze *et al.* 2005) are so far absent in Central Asia, perhaps not surprising as the research is quite new in archaeology. It is beyond the scope of this thesis to duplicate the Near Eastern DEM analysis methods in the Murghab context, but a general assessment of feasibility will be examined.

In order to investigate the utility of the ASTER DEM, the known large Bronze Age sites classed as ‘Depe 1’ in the AMMD designation (Bondioli and Tosi 1998: xvii), were overlaid on a colour-stretched DEM. The first examination was purely visual and attempted to assess the degree to which sites were discernible against the background topography. The results showed that although major mounded sites such as Gonur North and Togolok 1 did exhibit variability in elevation within their respective boundaries, none of the peak elevations within the site offered any substantial deviation from the natural topographic variation. Perhaps the most obvious reason for the lack of topographic prominence is that the Murghab landscape is heavily textured

as a result of dune formation. As noted above, the Quickbird panchromatic imagery clearly illustrates the degree of variability of the landscape, where dune ridges, hillocks, blow-outs, and depressions can all occur over an area of a few dozen square metres. The largest depes rarely surpass a few metres in elevation, rendering them indistinguishable from the surrounding topography. There is, however, one notable exception. This site, designated AKF3, was identified in the Adji-Kui Adam-Basan region as part of the current research. AKF3 constituted a large, high depe comprising approximately 3 ha, identifiable as an area of contiguous high elevation values on the ASTER DEM. Even in this case of a clear topographic signature, however, the sheer number of false positives in the landscape present dim prospects for automated site identification based on elevation although there may be some prospects for the development of algorithms in conjunction with other remote sensing imagery and higher resolution DEMs.¹⁰

The failure of the ASTER DEM to yield any useful information was not entirely surprising given the poor topographical contrast, even in field observations. Moreover, as other research has shown, the narrowest analytical scale may not always be the best for observation. Ur has observed that the lower resolution SRTM DEM actually performed much better in identifying tells in the Khabur region than did the sharper ASTER product (Ur *et al.* 2006). Although this observation may initially appear counter-intuitive, he notes that the high number of false positives as a result of the uneven topography of the landscape rendered the ASTER imagery largely ineffective in the identification of tells. In these findings, reduction in variability of the surrounding landscape provided by the SRTM imagery resulted in a greater prominence of the tells. In the Murghab, this problem of surface roughness was potentially a far more significant factor.

With these Anatolian results in mind, a logical question was the degree to which the ASTER imagery might respond to queries at ever-expanding analytical scales. If the fixed 30m resolution failed to yield any relevant elevation information that could be used to identify depes, could larger scales effectively smooth the topography enough to ascertain which peaks in altitude had the most potential? Topography is not necessarily manifested the same way at all scales (Fisher 2004), and a peak at close range may be nearly undetectable at broader scales of analysis. Anthropogenic mounds, similarly, may respond differently to different conceptions of scale. A relatively new method of addressing this variability is fuzzy classification, which

¹⁰ See, for example, the use of the Random Forest Classifier in Menze *et al.* (2007).

employs a probabilistic method to determine whether a feature falls into a particular topographical class. Membership is ranked on a 0-1 scale, where 1 indicates membership (i.e., peakedness) at all scales, and 0 represents no membership (see Fisher 2005; Fisher *et al.* 2007 for discussion). To conduct the analysis, the Landserf software package was used. First, a range of analytical scales was defined, ranging from a 3x3 to an 11x11 window size (0.81ha to 10.9ha). The 11x11 window constitutes a 10.9 ha area of analysis, significantly larger than the majority of sites in the delta with the exception of Gonur Depe. In terms of the topographical background, all scales revealed the expected unevenness of the landscape. This was unsurprising given the relative flatness over the DEM—the altitude ranges only 70m over 3,600 km²—so small changes in altitude were magnified. A fuzzy-peak classification was then run over the same multiscale rank. The results, shown in Figure 42, show the sites of Gonur Depe and Egri Bogaz, against a raster of peak membership in both ASTER and SRTM. Each of these sites has a recorded elevation of around 5m, compared to less than 3m for other sites in the delta (but see discussion on elevation in section 5.5.1). The figures indicate that no apparent relationship exists between sites and high-membership peaks. While peakedness does appear at certain levels, the extensive area of the sites increases the likelihood that, against such an uneven backdrop, some variation in the topography may occur, although the variation is too subtle and the false positives too many for variation to be detected using this algorithm.

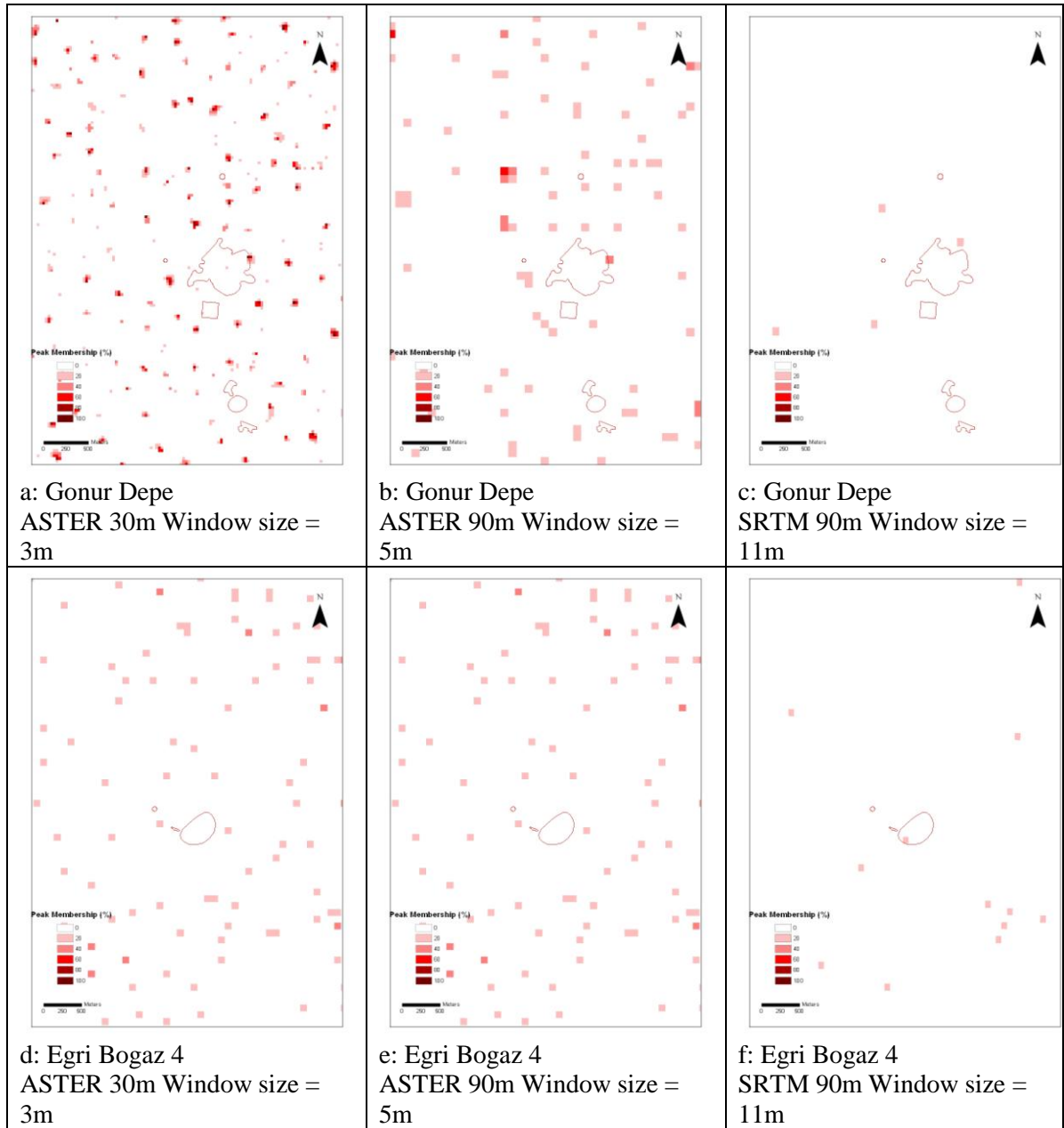


Figure 42. Fuzzy Peak Classification for Selected Sites (ASTER and SRTM DEMs)

4.5.2. Multispectral Imagery and Site Prospection

The second application of remote sensing for site prospection concerned the feasibility of identifying specific sites in the archaeological landscape through multispectral image classification. Supervised classification has recently shown promise in the identification of small tells in northern Syria using complex spatial, spectral and temporal classification algorithms (Menze and Ur 2007). The methodology used for this study proceeds at a more general level, assessing the degree to which it may be useful in conjunction with other techniques to investigate the study area. Because large sites, with the exception of Egri Bogaz 4, did not occur in the survey area, it was necessary to perform a delta-wide assessment first. The first step in the classification involved the selection of training data. These training sites consisted of Bronze Age sites identified as Depe 1 or 2 by the AMMD, as these tended to be visually prominent in the ASTER imagery. Unfortunately, it became apparent that the site boundaries as defined by the AMMD survey did not display any clear spectral contiguity, but were highly varied. Attempts to use these as training sites, even at a highly restrictive classification threshold, resulted in an enormous number of false positives—effectively including huge swathes of the landscape. While the discrepancy between site boundary and spectral contiguity may be partially due to the methodology used to measure the site, the actual complexity of the landscape even within a small region probably plays a significant role as well. In order to obtain more usable training data, regions of spectral contiguity were first manually selected from within the AMMD site polygons. ENVI's 'Grow' algorithm was then applied to digitally broaden the training area to include contiguous pixels of similar value. The spectral variation between training areas was then calculated using the Endmember Classification algorithm, the results of which are shown in Table 7.

In order to examine the effects of spectral variability on the potential for site identification, training sites were categorized into subgroups. Sites within a subgroup exhibited similar spectra, while the variability was higher between subgroups. The results of this test indicated that training sites within a specific subgroup were not able to effectively identify sites outside of that subgroup. One particular example is worth mentioning. The subgroup containing Kelleli 3 and 4, as well as that containing Egri Bogaz 1 and 2, both fall in agricultural zones in the northern delta. Because of this similarity, as well as the proximity of the Kelleli sites to the survey area, it seemed plausible that the Kelleli subgroup might be more effective as a training class for sites in the survey area than would central delta sites. When each group was used as a training group, however, the other sites failed to respond as positive hits. These investigations suggested that,

rather than using a single group of training sites, several subgroups should be explored to examine their effectiveness in isolating possible sites, as different sites may exhibit various characteristics in different landscapes (Beck *et al.* 2007a). Menze (2007), in his multispectral analysis of the Khabur basin, has come to a similar conclusion that landscape variability may heavily affect classification algorithms beyond about a 100 km radius. This particular distance, of course, pertains to the Khabur study and such distances should not be applied haphazardly without prior knowledge of the specific landscape of study. The visual assessment of the ASTER imagery indicates that, even over short distances, sites in different land categories may exhibit very different spectral signatures.

Table 7. Endmember Separability of Bronze Age Training Sites (all bands)

Sites	Internal Separability*	External Separability
Kelleli 3,4	Internal separability <0.5	External separability 1.8 from Togolok
Gonur N., Adji Kui 1, Adji Kui 8	Internal separability approx. 0.5	Adji Kui 1 slightly higher reflectance than Gonur and Adji Kui 8
Togolok 1	-	External separability 1.8 from Kelleli sites
Egri Bogaz 1, Egri Bogaz 2	Internal separability <0.5	External separability >1.75 from all site groupings

*N.B 'Internal Separability' here refers to the endmember separability between sites in each row of the table—i.e. those that show a similar spectral response. 'External Separability' compares these classes to each other. As indicated above, ideal separability indices should exceed 1.8, a figure also cited in the ENVI documentation.

After running the supervised classifications against the training data, these were applied to the full survey area. Classifications were run using a Maximum Likelihood algorithm at a threshold of 98%, then processed using a Sieve procedure that filters out stray pixels, and a Clump procedure that amalgamates the remaining data. Figure 43 clearly shows the enormous number of positive hits in two selected classifications, far too many to offer a reliable method of isolating individual sites. In certain cases, raising the detection threshold has been found to be useful in restricting possible positives (D. Thompson, pers. comm.). However, none of the previously identified sites within the survey area clearly correlated with the regions identified by the classification except for a small area around Egri Bogaz 4, which may be expected in such a varied landscape.

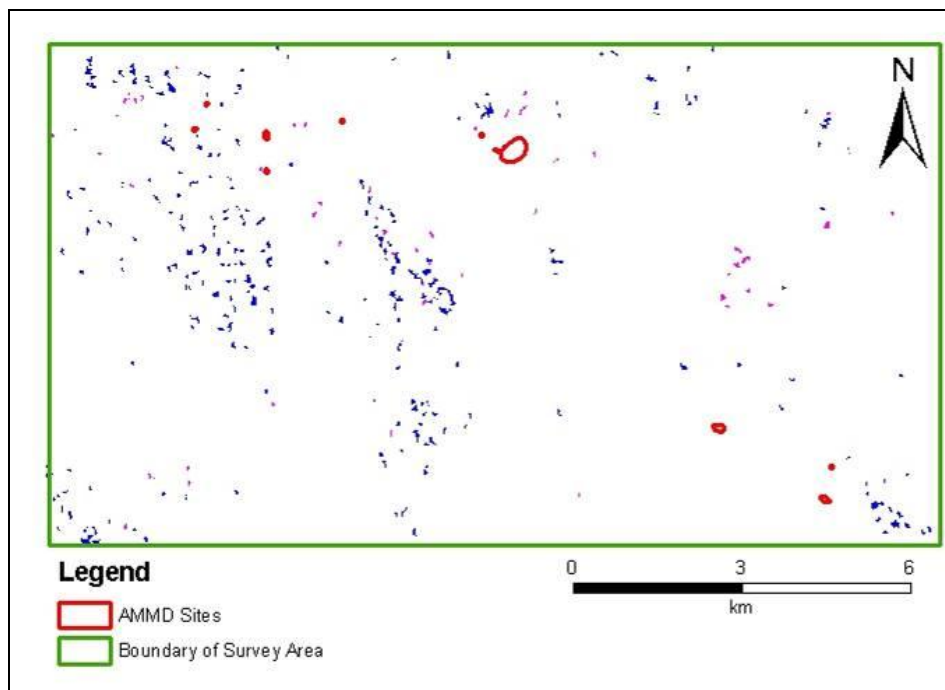


Figure 43. Selected Results of Supervised Classification. *Blue areas:* ASTER 7-3-1, Gonur/Adji Kui subgroup. *Purple areas:* ASTER 4-6-8, Kelleli subgroup

The results of the above test suggest that, at least in the northern delta, broad-scale supervised classifications were not an effective means to identify sites in the target area. There are several reasons that may account for this failure. One of these is simply the possibility that large, easily identifiable sites were not present in the survey area. The notable absence of any features that could clearly be considered depes, with the possible exception of the mounded areas in the Egri Bogaz 4 region, suggests that sites of the scale of those in the central delta simply may not exist in this particular area. A second reason, and one easily confirmed by field observations, is that sand cover and takyr erosion may significantly alter site signatures. As will be shown in Chapter 5, the site designated AMMD 717 is entirely obstructed by dune cover, and the pottery distributed on the surface of the adjacent takyr is much too sparse to be detected in the ASTER imagery (see study in Buck *et al.* 2003 on remote detection of surface pottery).

Given the inability to detect sites over a broad region, a more restrictive analysis was used to assess the performance of the classifiers in one particular region. Since at least three sites were visually detectable in the agricultural zone just south of Egri Bogaz 4 as opposed to none in the sand/takyr landscape, a mask was created to isolate just the agricultural region. Egri Bogaz 1 and 2 were selected as training sites, since they were the only clearly identifiable sites in the imagery. Again, the threshold was set to 98%. Unlike the previous tests, this classification

resulted in a very manageable set of nine possible site locations (Figure 44). Because of time constraints and accessibility difficulties due to irrigation, only five of these were visited. All test areas were found to be partially unploughed, often slightly raised and generally characterized by loose sandy deposits. Of the five, four were almost completely devoid of archaeological material, although the last site contained a few small ceramics at the edge of the loess, continuing a few metres into the ploughed fields. At the moment, there is no clear basis for labelling this a ‘site’, although there may have been some occupation in the vicinity. However, it appears that in the agricultural zone, the positive results of the supervised classification are caused by the higher reflectance of unploughed areas rather than any specific spectral characteristic of archaeological settlement.

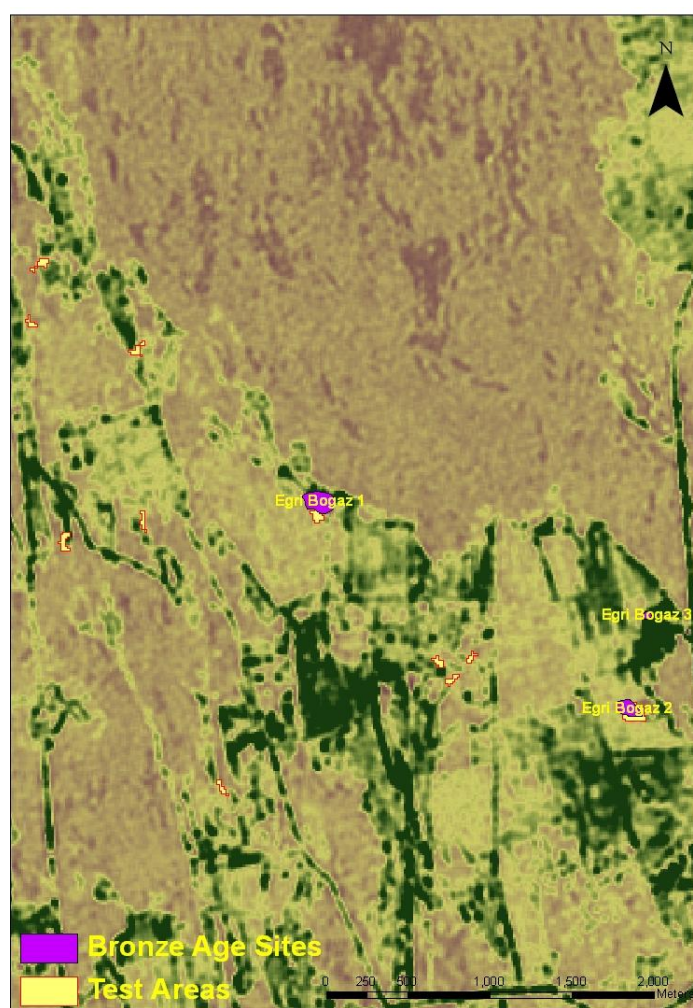


Figure 44. Test Sites from Supervised Classification near Egri Bogaz 1

4.5.3. Multispectral Characteristics of AKF3, a New Site in the Central Delta

Although a remote sensing analysis of the central delta was not a focus of the research, one result, independent of the above classifications, merits some discussion. Visual analysis of the ASTER data prior to the survey revealed a large, roughly circular region of spectral contiguity. In order to explore the feature more closely, agricultural areas were masked out as described above, rendering only dunes and takyrs visible. The masked image clearly revealed two distinct features to the south of Adji Kui, both characterised by contiguous regions of higher reflectance in ASTER band 9 (Figure 45). In order to further enhance the image, a 9-3-1 band combination was found to be especially effective. Of the two sites identified in this manner, one of these was subsequently identified as AMMD site 410, an elevated region containing Late Bronze material. The second was undocumented in the literature, and subsequent field investigations identified a large, well defined depe amidst a dune landscape, measuring approximately 3 ha (Figure 46). To denote proximity to the Adji Kui sites, the new site was informally termed NMDS AKF3 (Adji Kui Found 3). Ceramic density on top of the depe was extremely high, and the visible difference in colour was very clear on the ground. Approximately 500m to the west, another area of moderately high sherd density was discovered, covering roughly one hectare. Both areas contained high concentrations of diagnostic sherds, bits of metal, and a large shell, some of which were collected in order to establish a general chronology of surface material (Figure 47). The ceramic density and large quantities of eroded mud brick may contribute to the clear spectral definition, primarily in the middle IR Band 9.



Figure 45. Comparison of Image Enhancement Techniques for AKF3

Visually, AKF3 exhibited similar spectral characteristics evident in other large sites in the central delta, particularly Gonur North and Adjı Kui 8, although unlike these sites AKF3 revealed a much clearer spectral uniformity. It should be noted that pottery cover on the surface of the mound was extremely dense, and even a visual observation of the depe surface reflected a more reddish hue. Consequently, it is possible that the combination of deflated architecture and the pottery cover contributed to the clearer spectral signature. Moreover, as archaeological work has not been conducted here, it is pristine compared to other major sites, a factor that may have contributed to its detectability.



Figure 46. 'AKF3' facing southwest.



Figure 47. Surface Pottery from 'AKF3'

4.6. Summary

If scale is to be considered an underlying theme of this research, and remote sensing a specific methodological approach, then this chapter can be seen to integrate these at the broadest analytical level. The results represent a series of representative snapshots from space that can be used to model landscapes, not duplicate them. However, while classifications and thresholds cannot take the place of actual field observations, they can make a broad area much more manageable from an interpretative perspective. The above results suggest that, while remote sensing data may be limited in its ability to investigate the actual archaeology of the northern delta, it is useful in terms of assessing general land types and recovery potential, a finding that bodes well for survey in similarly complex or inaccessible environments. Satellite imagery also, as evidenced from the stronger spectral signatures in the central delta, has potential for the detection of larger, more uniform sites. The variable sand cover in the northern delta, however, combined with a poor sample by which to define site spectra posed problems for site identification. While the potential for multispectral rather than DEM-based site classification methods should not be ruled out, such work would probably best operate at small scales of analysis, and more intensive geomorphological research is needed to fine-tune classes and algorithms. The variability of the landscape at close range, and its relationship to observable patterns of surface material, are a primary focus of the following chapter.

Chapter 5. Results of Field Survey

5.1. Overview

The preceding chapter employed remote sensing data to describe and, where possible, quantify, the NMDS survey landscape and to identify some of the biases that may potentially affect recovery potential. This chapter returns to more traditional archaeological practices and discusses the findings of the survey itself. In keeping with the overarching concept of scale, the chapter begins with a brief discussion of the other Egri Bogaz sites before focusing the window on the survey area from both a geomorphological and a material perspective. It then addresses each region of the survey, categorised by analytical units as described in Chapter 3.

5.2. Reconnaissance of Egri Bogaz 1, 2 and 3

Immediately prior to the survey, the three southern sites of the Egri Bogaz complex, Egri Bogaz 1, 2 and 3, were visited in order to gain a clearer understanding of the local archaeological environment. While no formal reports have been published, surface distributions and small 2x2m soundings have yielded diagnostic material and some kiln remains (B. Udeumuradov, pers. comm.). Udeumuradov indicates that these three sites were largely damaged by agricultural development, and subsequent AMMD investigations suggest that all three sites were ‘partially under the plough’ (see comments in AMMD GIS database). Although these sites have been heavily affected by agricultural development, the damage was not as severe as might have been expected. All three sites proved easily identifiable on the ground, although only Egri Bogaz 1 and 2 are identifiable in the ASTER satellite imagery as bright areas clearly distinguishable from the surrounding fields. The unploughed portions of all three sites are characterised by loose sandy deposits with moderately dense surface scatters.

A cursory field investigation of Egri Bogaz 1 revealed a partially excavated kiln, surrounded by a high density of pottery and brick debris. Beyond this region, surface materials decreased until ending fairly abruptly at the edge of a large cotton field to the east, although a secondary concentration continued to the north. Egri Bogaz 2, comparable in size to Egri Bogaz 1, straddled a region of loose, windblown sand in the east and a large field extending

approximately 1 km to the west. The actual dimensions of either site were thus difficult to determine, and portions of each were covered with dense vegetation. The density of material on Egri Bogaz 2, while not systematically sampled, was higher and more widespread than in Egri Bogaz 1, and brick debris, some of it vitrified, was found near the centre of the site. The surface material on Egri Bogaz 2 continued into the fields, more so than at Egri Bogaz 1, although this may be the result of previous ploughing rather than an actual reflection of the size of the site (see Francovich 2000). The last of the three sites, Egri Bogaz 3, was a small, low mound located about 500m north of Egri Bogaz 2. Surface materials were much less dense here, and did not continue beyond the surface of the mound. Egri Bogaz 3 is the only site of the three that escaped detection by the ASTER imagery. This was most likely due to its small size rather than any unique spectral characteristics, since all three sites contained similar surface deposits. Applications of higher resolution imagery such as IKONOS or Quickbird may be useful to examine these sites more closely, given their effectiveness in detecting small ploughed-out regions in Syria and Anatolia (Beck *et al.* 2007b), although with the exception of Egri Bogaz 1, these were unavailable for the survey area.

5.3. General Field Observations in the NMDS Survey Area

Before providing a detailed examination of the survey data, it is necessary to look more closely at the landscape as observed in the field. Although the survey area comprises only a small region of the Murghab, the geomorphology may be seen as an approximate microcosm of the northern delta as a whole. Takyr comprise about 3.7 km², or about 31% of the survey region. Most of the exposed takyr surface is concentrated in two distinct areas: one in the northwestern portion of the survey area, of which nearly half is comprised of a large, mostly unvegetated takyr, and the other in the vicinity of Egri Bogaz 4. This latter takyr complex is discontinuous, and broad areas of the eroded takyr surface are regularly interspersed with variable sand cover. Several hundred metres to the south begins the northern fringe of a heavily cultivated region, although these fields do not encroach on the survey area. A third takyr region, almost entirely cultivated, comprises the region between these two takyr zones, and obstructs about 2 ha of the survey area. The rest of the landscape is comprised primarily of variable dune cover. Interspersed throughout this dune-takyr complex are numerous over-sanded depressions, and it was primarily within these low-lying regions, either depressions or the over-sanded perimeters of takyr, where material tended to be most prevalent.

Indications of fluvial activity throughout the survey area were common, although the identification of specific channels was difficult due to the complex geomorphology and land cover, and various geomorphological processes may complicate channel identification in different ways. In some cases, takyr sediments may completely obscure natural palaeochannels, and Cattani (2008b: 127) has observed such a process near site 1211, where the alluvial sediments were detected 80cm below the surface. In other cases palaeochannels have become over-sanded, resulting in the eventual development of sand ridges that may completely obscure the original fluvial geomorphology. An interesting comparison may be drawn with Sarianidi's identification of a 25m high sand ridge as an artificial canal (Sarianidi 1990:55). In the survey area itself, several features were identified as having possible fluvial characteristics, based on their winding trajectories and approximate NNW-SSE orientation, although river systems are complex and branching and individual channels may not necessarily match this profile (see map in Section 1.8.2). Gravel deposits, often a good indicator of channel activity (Deckers and Riehl 2007), were almost entirely absent, although sporadic washed stones were found in the eastern portion of the survey area. Another indicator of probable riverine activity was the widespread occurrence of tiny shells (Figure 48), which Lioubimitseva (2003) associates with a freshwater environment. Such shells may be associated with irrigation canals or palaeochannels as well (Madsen 1992), and while the sporadic occurrence of these shells precluded the identification of clear patterning in their dispersal, there was some evidence of linearity along a possible fluvial corridor in the west (for discussion see section 7.7). The most likely indicators of fluvial activity were quasi-linear chains of takyr, usually a few metres or more in width, and bounded by low, vegetated sand ridges that ran slightly northwest of the general trajectory of the landscape. Vegetation on the surface of the takyr themselves appears to be primarily related to the degree of oversanding of the takyr surface (Fleskins et al. 2007).

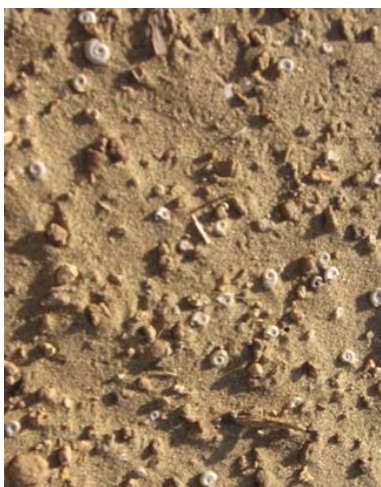


Figure 48. Riverine shells

A notable feature that was occasionally observed in the survey area was an extremely fine deposition of sand and pottery grains, most of which were only a few millimetres or less in diameter. While these usually occurred within range of moderate or high-density pottery scatters, they were sometimes more isolated, although rarely found in areas completely devoid of surface sherds. Often, these distributions occurred in conjunction with wind-blown sands, usually towards the base of sand dunes or in oversanded depressions. The minute size of the material suggests deposition via aeolian processes, carried by wind-blown sands and consequently separated from larger material (A. Ninfo, pers. comm.).

5.4. Overview of the Survey Data

An initial assessment of the surface distribution (Figure 49) revealed widespread material and sherd totals as reported by the fieldwalkers numbered over 22,000 for the entire 11 km² survey area. The vast majority of these, although generally non-diagnostic (see Chapter 3), were datable to the Bronze Age although the Sasanian and Islamic periods were also represented in diagnostic material but in much smaller quantities. Clearly evident, even at this level, was the sheer variability of the material distribution. High-density areas in Area 1 may be loosely associated with the Egri Bogaz 4 occupation, and secondary concentrations in Area 4 form the basis for the sites designated 717 and 718 by the AMMD researchers. In the intervening regions between these zones, as well as to the south of Area 4, broad areas of low to moderate densities are evident, and it was not difficult to discern the ‘continuous distribution’ of material as described by the AMMD research team (Cattani and Salvatori 2008). At the same time, this

continuity exhibited clear variability, and certain patterns, notably the north-south banding in the western portion of Area 1, were likely influenced by the current geomorphology of the region (see section 6.5).

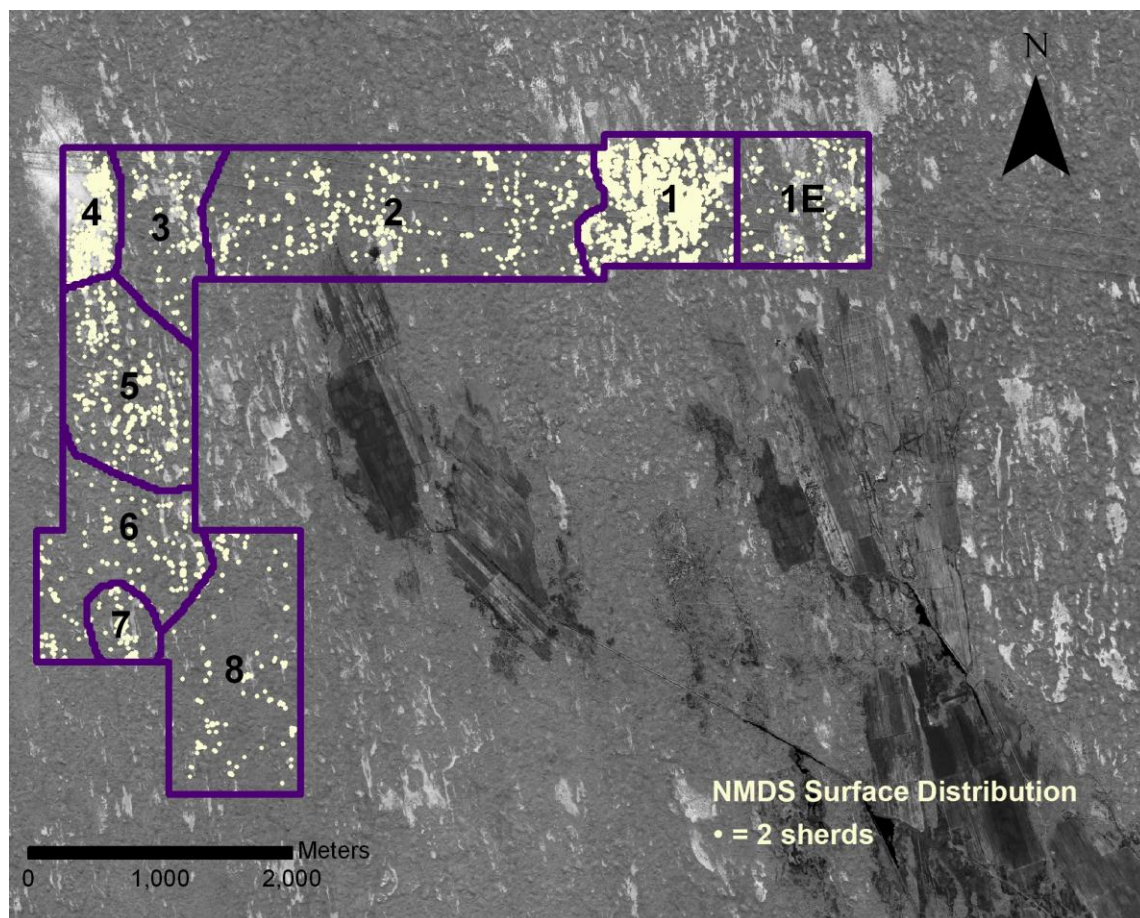


Figure 49. Distribution of All Surface Pottery
(Numbers indicate analytical units)

Analysis of the surface distribution, discussed qualitatively in this chapter and quantitatively in Chapter 6, posed an immediate difficulty: in a study of the Bronze Age Murghab delta, how should later (i.e. Sasanian and Islamic) materials be handled? The presence of Sasanian and Islamic material in the survey area cannot be discounted, but its existence introduces some error in any quantitative assessment of Bronze Age spatial patterning. Several possibilities of rectifying this problem were explored. One straightforward method is to estimate sherd totals based on probabilities, using percentages of diagnostics from each period to calculate the percentage of total sherds from that period. Applicability of such methods in the NMDS area is questionable, however. Diagnostics were limited, and the vast majority originated in a fairly concentrated portion of Area 1. While an individual scatter might be datable from a diagnostic sherd, it would be presumptuous to assign, for example, a date to a dispersed, 2 hectare

aggregation with one Bronze Age rim and two fragments from a Sasanian water jar. Moreover, later materials were much less abraded, and fragments were often larger, suggesting that the myriad small dispersed fragments, even if later diagnostics were more prevalent, are more credibly associated with earlier material. One notable exception occurs in the central region of Area 2, where several unglazed diagnostics were representative of mid-late Sasanian or Early Islamic periods (D. Gilbert, G. Puschnigg, pers. comm.). However, such contexts responded well to qualitative examination, and the analysis employs the full distribution of materials unless otherwise indicated.

One of the more straightforward methods of interpreting distributional survey data, widely used in the Aegean and elsewhere employs simple sherd counts (e.g. Bintliff and Snodgrass 1988). Where ‘sites’ tend to be the typical base units of large scale projects (see section 2.7), surveys that look more at systems, continua, or offsite behaviour usually require some metric for measuring the continuous distribution of material. Often, the core empirical data takes the form of sherd counts or densities per unit area, which may be standardised as sherds per square metre or some similar measurement (Mattingly *et al.* 2000). While some manner of measuring pottery density is usually necessary if any quantitative or statistical data is to be performed (contra Fentress *et al.* 2000), the process is often difficult or impossible to standardise, not only from project to project, but even within a single survey. Despite these difficulties, much can be learned by analysing basic sherd counts for the NMDS survey as a first step in understanding the overall distribution of material.

Table 8 shows the average density of the surface material for all periods throughout the NMDS survey region, in conjunction with the percentages of collection units containing artefactual material. It should be noted that these figures represent sherd densities as recorded by the walkers and, because of the unreliability of arbitrary scaling factors (cf Bevan and Conolly 2006), have not been scaled up to represent entire collection units (but see following discussion). Over the entire survey area, mean recorded densities were extremely low, at 0.2 sherds/100m². Moreover, this number factors in the extremely high densities in the Egri Bogaz 4 region, and the figure drops to 0.03 sherds/100m² when this area is excluded. These low densities are a little misleading, and the 20m spacing of the walkers may be expected to significantly reduce sherd totals. Moreover, the speed at which each transect is walked further affects recovery rates. The average time to traverse a 20m collection unit was approximately one minute, sufficient to identify material within visible range for low to medium density regions although, as expected, accuracy decreased with higher sherd totals (see also section 8.1). By applying an arbitrary scale

factor that assumes that each walker records sherds up to 1-2 metres on either side, we may tentatively scale densities upwards 5-10 times. Clearly however, such simple scalar modifications are inaccurate, and visibility potential varies heavily with geomorphology. In high-visibility areas such as takyrs, walkers may be able to see sherds much further than 2 metres away. At the same time, sand cover may obscure 50-90% of the landscape, and nearby pottery may be obscured by small sandy deposits. While such scaling methods are therefore simplistic, they do tend to place overall densities within range of other offsite projects in more heavily studied regions in the Mediterranean and Middle East. Bintliff and Snodgrass (1988: 510), for example, note a progression in absolute sherd densities moving from the moister northern European climates, through the more arid dry-farming zones around the northern Mesopotamian sites, with the highest levels in the hyper-arid regions in Oman. He links this density gradient primarily to the convergence of climatic and geomorphological factors, and while the realities may be much more complex and localised in nature, it is not unreasonable to suggest that densities in the Murghab, if standardised to other projects, broadly rest within this continuum.

Looking more closely at the numbers, a few basic patterns may be observed at the outset. Area 1 and Area 4, where surface material was abundant, clearly exhibit the highest sherd densities at 1.38 and 0.7 sherds/100m² respectively, and over 25% of the collection units in each contained surface material. Although the irregular shapes of the analytical units may affect these metrics (see discussion on the MAUP problem in Section 2.10), densities in these regions are about four or five times those found elsewhere in the survey area. Sherd ‘clusters’, an arbitrary metric designating 5 or more artefacts, represent about a quarter of collection units that contain material, a figure that increases to over one-third in the high-density areas. As might be expected, this tendency indicates a more integrated pattern of surface scatter in the high density areas. It also suggests that isolated material is less prevalent with respect to the overall distribution in these more heavily occupied regions.

Table 8. Densities by Analytical Unit (sherds per 100m²)

Analytical Unit	Density	% Positive Collection Units (at least 1 sherd/unit)	% Clustered (over 5 sherds/unit)
01E	0.0375	5.7%	1.7%
01	1.38	29.8%	14.7%
02	0.04	5.3%	0.88%
03	0.02	0.89%	0.2%
04	0.7	27%	9.1%
05	0.05	6.6%	1.0%
06	0.075	8.2%	1.78%
07	0.0325	4%	0.5%
08	0.015	2.2%	0.3%
NMDS Average Sherd Density: 0.2/100m ²			

5.5. Visibility in the Survey Area

5.5.1. The Effects of Land Cover on Sherd Density

The previous chapter employed remote sensing to develop a thematic model of the NMDS survey area useful in the assessment of visibility, and this model may now be used to investigate the relationship between land cover and the surface distribution introduced above. In order to investigate this relationship, a 5-class supervised classification was used (see previous chapter). Since the 2.5m resolution afforded by the Quickbird imagery was significantly smaller than the potential lateral error of any particular sherd, the raster was downsampled to a 10m resolution using a modal resampling algorithm, which resulted in a resolution still high enough to retain some information from the Quickbird imagery that would likely have been lost at a lower resolution. In order to minimise the number of pixels that could be represented in two or more collection units, this classification was then resampled to 5m. While there are still numerous sources of error with respect to the land type underlying any particular sherd, this method was helpful in assessing general trends in the landscape.

Table 9 and Table 10 illustrate the relationship between land cover and raw sherd counts, both for the entire NMDS region as well as for individual analytical units. As an initial assessment of the effect of land cover on distribution, a univariate chi-squared test was applied, using the percentage of each land type to calculate expected sherd counts. The results indicated statistically significant relationships ($p < 0.001$) between raw counts and land types. To examine these relationships more closely, it was necessary to assess the surface material in specific land cover categories.

Table 9. Effects of Land Cover on Sherd Counts

Full NMDS Survey Area		Sherd Totals		Units w/ 1 Or More Sherds		Units w/ 5 or More Sherds		Units w/ Single Sherd	
Land Type	Land Cover %	Obs	Exp	Obs	Exp	Obs	Exp	Obs	Exp
Dry Takyr	1.93	559	426	110	43	22	13	48	18
Variable Dunes	61.54	14242	13573	1049	1379	352	412	424	563
Moist Takyr	3.10	773	683	118	69	40	21	41	28
Stable Dunes	14.19	707	3131	183	318	36	95	99	130
Oversanded Takyr	19.23	5774	4242	781	431	220	129	303	176
	100.00	22055	22055	2241	2241	670	670	915	915

Table 10. Effects of Land Cover on Sherd Counts by Analytical Unit

	AU1			AU2			AU3			AU4		
LAND TYPE	Land Cvr %	Obs	Exp	Land Cvr %	Obs	Exp	Land Cvr %	Obs	Exp	Land Cvr %	Obs	Exp
Dry Takyr	0.56	62	88	0.16	4	2	1.41	8	3	33.51	458	1015
Variable Dunes	63.85	11887	9987	88.52	1023	1051	56.76	64	106	15.93	582	483
Moist Takyr	7.26	657	1136	1.66	18	20	3.17	1	6	0.60	2	18
Stable Dunes	1.54	77	241	2.85	71	34	6.99	8	13	0.26	0	8
Oversanded Takyr	26.78	2958	4189	6.82	71	81	31.68	106	59	49.71	1987	1506
	AU1E			AU5			AU6			AU8		
	Land Cvr %	Obs	Exp	Land Cvr %	Obs	Exp	Land Cvr %	Obs	Exp	Land Cvr %	Obs	Exp
Dry Takyr	3.53	18	13	0.08	0	1	0.51	2	2	0.01	0	0
Variable Dunes	46.39	133	176	42.65	294	296	26.26	75	112	84.56	179	236
Moist Takyr	7.65	30	29	5.47	48	38	1.54	9	7	0.65	8	2
Stable Dunes	0.38	5	1	18.66	109	130	61.84	211	264	8.90	49	25
Oversanded Takyr	42.06	194	160	33.13	244	230	9.86	130	42	5.89	43	16

N.B. Analytical Unit 7 not included because of its extremely small area

The clearest evidence of a relationship between land type and material was in the Stable Dunes and Oversanded Takyr categories. Sherd totals were regularly suppressed in the former, exhibiting reductions of well over 50% both in total counts and in the 5-or-more category. The slightly less pronounced effect in the 1-or-more category was most likely attributable to the tendency of isolated sherd fragments to occur at a slightly less than expected rate in these regions. While isolated material was still affected by dune cover, the effect was much more pronounced in more significant material scatters. Balancing out the reduced sherd totals in the Stable Dune category were significant increases in all three takyr categories. The initial conclusion to be drawn from such trends is one that is well attested—if not quantitatively confirmed—that the visibility of surface material is likely to be affected by heavy dune cover, and that by far the most conducive land types for recovery are regions where the alluvial surface is exposed.

Because of the significant geomorphological variability in the landscape, it cannot be assumed that these effects will remain constant across the entire landscape. In Area 1, the region with by far the highest density of material, there was actually an increase in sherd totals in the variable dune category, in contrast with other regions. Several factors may account for this anomaly. One is that the sheer numbers of surface sherds over a wide area was simply too high to be significantly restricted by land types. In regions with thousands of sherds, significant spill-over into potentially more visually restrictive areas was common, and additional work associated with pipeline excavations may have confounded this problem. In addition, the occurrence of

significant sherd scatters on the surface of over-sanded mounds in several locations could be expected to inflate the totals in sanded regions as well. Area 8, by contrast, actually indicated an increase for counts in more stable environments, but a significant decrease for counts in variable dune regions.

The distribution in sanded areas elsewhere is similarly complex. The effect of variable dunes on visibility was not readily apparent in the offsite Area 2 and Area 5. One factor in both of these regions may be the increased presence of late-period materials which may occur more readily atop sanded regions that developed in the post-Bronze Age period (see Chapter 5). This is, however, speculative, and the comparatively low numbers of Sasanian and Islamic surface sherds combined with the fact that eroded material is more likely to derive from earlier periods (section 5.8.3) suggests that this impact would be minimal. A clearer trend may be seen in the western portion of the survey area, where the significant reduction of surface material in stable dune environments may be explained by the presence of wide swathes of low, rolling dunes that suggest a highly stable landscape. An additional factor may be the occasional presence of broad, shallow fields of windblown sands in this particular region, which could be expected to further restrict visibility.

In alluvial regions, perhaps the most surprising result was the consistent failure of the Dry Takyr category to yield a comparatively high proportion of surface material, although it represents a region of high visibility. This was particularly striking in Area 4, where the presence of significant quantities of surface material scattered on the broad takyr suggested that this would be a likely location for inflated counts on the takyr surface. Instead, observed counts were actually about 50% lower than the expected total. A countervailing factor may again be seen in the preponderance of material on the over-sanded takyr surface, corresponding to oversanded and more eroded regions. It must be noted that this particular classification did tend to underestimate the prevalence of the unvegetated takyr surface, which would certainly contribute to lower sherd counts. However, the consistent high values in the sanded takyr zones—even in area 1E, where broad regions of exposed takyr yielded no material at all, offers a clear indication that the boundary areas between dune and takyr are highly significant in terms of recovery potential.

5.5.2. The Effects of Visibility on Sherd Density

The above analysis has demonstrated that, as expected, sherd counts are likely to be suppressed in general regions of high sand cover, and general increases tend to occur in eroded takyr regions, which heavily contribute to oversanding. Land cover, however, cannot be treated as a direct substitute for visibility, and it is useful to explore the concept in more detail. As noted earlier, visibility tends to be treated in a simplistic manner in the Murghab, where sand cover is directly linked with site obstruction. While the reality is much more complex, field observations strongly supported the assumption that regions where heavy dunes were prevalent tended to yield fewer surface sherds, while pottery was clearly visible on takyr and in sandy depressions. The quality of the dune cover also played a role. Stable dunes contributed the most to restricted surface material, while sherds were often easily identifiable amid locally deposited sands resulting from takyr erosion. Using the information derived from the supervised classification, it was possible to propose a Sand Cover Index (SCI) that can be used to assess the potential visual obstruction as a continuum, as follows:

$$\text{SCI} = (\text{Sum of sand classes} / \text{Total}) * 100$$

where the sand classes comprised ‘Stable Dunes’ and ‘Variable Dunes’. By assessing sand cover as a percentage of the collection unit, an allowance could be made for regions where material may have aggregated in and around small depressions, a situation that was difficult to trace in the above analysis. Fully obstructed regions, therefore, would be expected to yield low material densities, while partially obstructed collection units would be more variable. The resulting raster, shown in Figure 50, was first resampled from the original 2.5m resolution of the Quickbird multispectral imagery to a finer 0.5m resolution in order to minimise the effect of raster cells that lay on the border of two or more collection units. As expected, the large, contiguous takyr regions show up as high visibility (low SCI) zones, while the broad regions of heavy sand cover commonly found in the southern portion of the survey area exhibit high SCI levels. The index in Area 2 shows a trend from obstructed visibility in the western part to highly varied values in the east, corresponding to small, intermittent regions of exposed alluvium in an otherwise heavily sand-covered region. Interestingly, the main road, where sherds tend to be highly visible, is largely undetectable outside of Area 1. This is presumably a result of its predominantly sandy composition, and the sherd visibility here most likely relates to recent redeposition of material rather than to any archaeological or geomorphological factors.

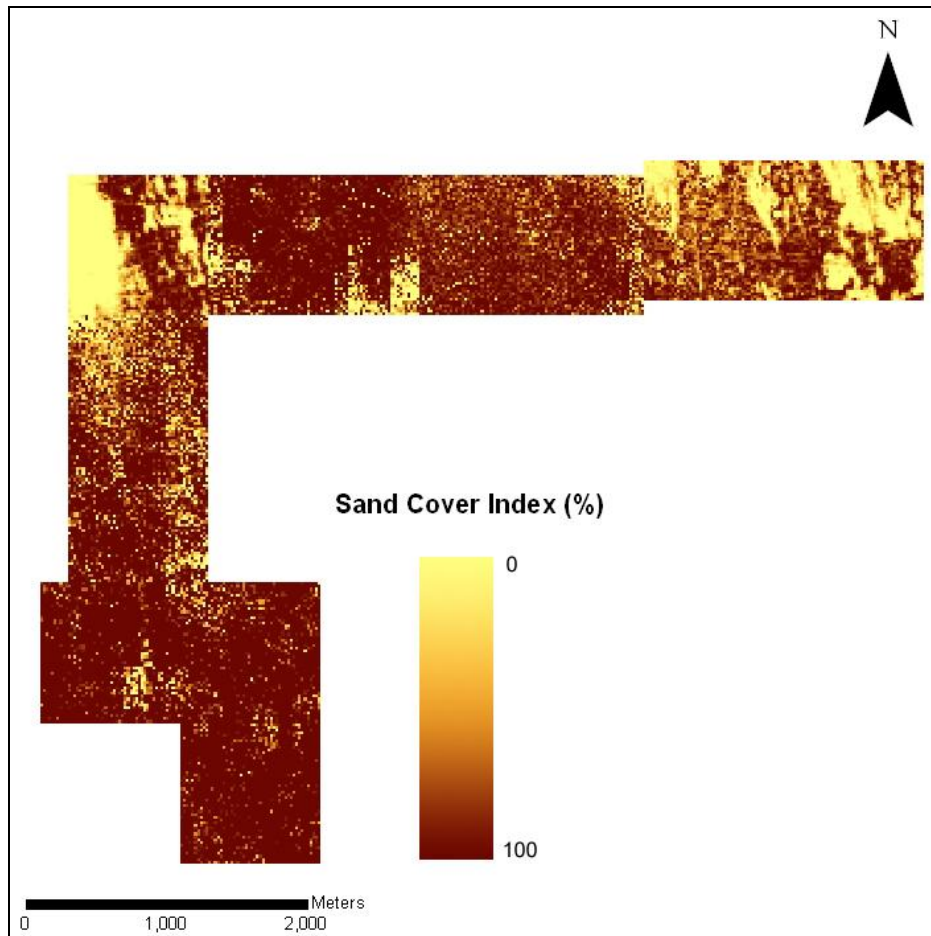


Figure 50. Sand Cover Index for NMDS Survey Area

A chi-squared test can again be used to assess and confirm any patterns in sherd density with respect to visibility. Since the SCI varies from collection unit to collection unit, a 3x3 low pass filter was generated using the mean of the neighbouring SCI values, which better characterises the demonstrably continuous nature of the sand cover. The resulting raster was divided into 5 sand cover classes, ranging from 0 to 100. The results of the analysis can be seen in Table 11 and

Table 12. In most cases, discrepancies between observed and expected values are high and a significant overall relationship clearly exists between sand cover and surface material. In general, lower obstruction by sand was associated with higher raw pottery counts, with a significant visibility restriction occurring at the highest SCI levels, which would be expected. A surprising find, perhaps, was that observed counts for the full survey area were much higher than expected for the 60-80 range, however, this is likely influenced by anomalous behaviours in Area 1 where the confluence of a highly variable landscape, heavy overall sherd cover, and the anomalous presence of high sherd totals on mound surfaces skewed the count in this area. The fact that this same anomaly occurs for clustered ceramics further supports this finding, and suggests that visibility patterns in high-density areas are likely to be quite different from those in other regions. In general, consistent trends can be seen in offsite regions, although the patterns within the different ranges are less subtle, due in part to much lower sherd totals. Particularly among clusters of 5 or more in the offsite region, the chi square test indicates significance—particularly due to a high number of observed clusters in the 40-60 range. The overall picture, then, appears to be one where sand cover is a factor, but one that is difficult to express as a simply graduating trend.

Table 11. Relationship between SCI and Sherd Totals

NMDS	Total Counts		Clusters (5 or More)		
SCI (Full Survey Area)	Observed	Expected	Observed	Expected	Chi. Sq.
					155.7, p<0.001
0-20	2817	1432	115	44	
20-40	1703	917	42	28	
40-60	3258	1609	120	49	
60-80	10238	4094	228	124	
80-100	4039	14002	165	425	
SCI (Low Density Regions Excluding Areas 1 and 4)	Observed	Expected	Observed	Expected	Chi Sq.
					13.87, p<0.001
0-20	113	99	2	5	
20-40	181	119	6	6	
40-60	379	212	21	10	
60-80	633	560	30	27	
80-100	2079	2395	106	117	

Table 12. Relationship between SCI and Sherd Totals by sherd count categories

SCI (%)	Sherd Count = 0		Sherd Count 1-5		Sherd Count 5-20		Sherd Count > 20	
	Obs	Exp	Obs	Exp	Obs	Exp	Obs	Exp
0-20	2488	2827.6	442	187.9	105	42	37	21
20-40	1070	1128.3	114	75	26	16.8	18	8
40-60	1400	1486.3	147	98.8	42	22.1	29	11
60-80	2549	2632	206	174.9	64	39.1	47	20
80-100	17739	17171.9	769	1141.3	138	255	57	128
Chi-sq (df=4, p<0.0001)	56.5		557		203.5		146.83	

In order to perform a more localised analysis, it was necessary to look more closely at the SCI for individual analytical units. To do this, a generalised linear regression model (glm) was employed to further explore potential correlations between the Sand Cover index and the potential for surface recovery. The glm is similar to a standard linear regression, although it offers much greater flexibility for different kinds of dependent variable and is better suited to non-normal distributions (Venables and Ripley 2002: 183). The regression analysis was run on the entire survey area as well as individual analytical units. Three separate regressions were run using a quasi-Poisson model (for the use of this method, see Bevan and Conolly 2009: 960-3): one using all sherds over all collection units (including zero-counts), the second on only positive squares, and the third on collection units in which 5 or more sherds were present. The results, shown in Table 13, indicate a significant negative correlation over the entire survey area when zero-valued squares are considered, but not for the subsets of $n \geq 1$ or $n \geq 5$. categories showed any significant correlation either over the full survey area or for individual analytical units. This suggests that the inclusion of the zero-valued squares, which correlate strongly with low-visibility units, have a significant effect on the overall regression. This relationship is even clearer when we simply deal with presence versus absence of sherds and perform a logistic regression, where the correlation between SCI and sherds total is negative in all cases at a significance level of $p < 0.01$. Ultimately, the analysis suggests that an increase in sand cover implies a greater chance of zero sherds counts, but also implies that modelling any specific decreasing trend in actual densities based solely on visibility would be unreliable (cf Bevan and Conolly 2004).

Table 13. Regression Analysis--Generalised Linear Model

All Collection Units						
	Quasi-Poisson			logistic		
	coefficient	t-value	p-value	coefficient	z-value	p-value
Full Region	<i>-0.015</i>	<i>-8.317</i>	<i>< 2e-16</i>	<i>-0.0161794</i>	<i>-28.16</i>	<i>< 2e-16</i>
AU1	<i>-0.002</i>	<i>-0.865</i>	<i>0.387</i>	<i>-0.013</i>	<i>-10.5</i>	<i>< 2e-16</i>
Positive	<i>0.008</i>	<i>2.622</i>	<i>0.00891</i>			
Clustered	<i>0.005</i>	<i>1.745</i>	<i>0.0818</i>			
AU1E	<i>-0.006</i>	<i>-2.01</i>	<i>0.0445</i>	<i>-0.008</i>	<i>-3.6</i>	<i>0.000312</i>
Positive	<i>0.006</i>	<i>0.412</i>	<i>0.681</i>			
Clustered	<i>-0.003</i>	<i>-1.064</i>	<i>0.304</i>			
AU2	<i>0.0004</i>	<i>0.095</i>	<i>0.925</i>	<i>-0.005</i>	<i>-2.3</i>	<i>0.01</i>
Positive	<i>0.0005</i>	<i>1.712</i>	<i>0.0879</i>			
Clustered	<i>0.008</i>	<i>1.384</i>	<i>0.1732</i>			
AU3	<i>-0.01</i>	<i>-2.358</i>	<i>0.0184</i>	<i>-0.019</i>	<i>-10.09</i>	<i>< 2e-16</i>
Positive	<i>-0.03</i>	<i>0.076</i>	<i>0.94</i>			
Clustered	<i>0.005</i>	<i>0.65</i>	<i>0.51</i>			
AU4	<i>-0.06</i>	<i>-3.489</i>	<i>0.000505</i>	<i>-0.030427</i>	<i>-9.414</i>	<i>< 2e-16</i>
Positive	<i>0.001</i>	<i>-1.586</i>	<i>0.115</i>			
Clustered	<i>-0.02</i>	<i>-0.0801</i>	<i>0.426</i>			
AU5	<i>-0.005</i>	<i>-1.66</i>	<i>0.097</i>	<i>-0.007897</i>	<i>-3.609</i>	<i>0.000307</i>
Positive	<i>0.00139</i>	<i>0.479</i>	<i>0.633</i>			
Clustered	<i>0.0002</i>	<i>0.058</i>	<i>0.954</i>			
AU6	<i>-0.02</i>	<i>-2.955</i>	<i>0.00323</i>	<i>-0.028224</i>	<i>-5.832</i>	<i>5.46e-09</i>
Positive	<i>0.0013</i>	<i>0.172</i>	<i>0.86445</i>			
Clustered	<i>0.012</i>	<i>1.578</i>	<i>0.1354</i>			
AU7	<i>0.0002</i>	<i>0.278</i>	<i>0.781</i>	<i>-0.007503</i>	<i>-2.376</i>	<i>0.0175</i>
Positive	<i>0.009</i>	<i>1.218</i>	<i>0.225</i>			
Clustered	<i>0.012</i>	<i>0.897</i>	<i>0.3791</i>			
AU8	<i>-0.02</i>	<i>-4.392</i>	<i>1.15E-05</i>	<i>-0.01</i>	<i>-5.3</i>	<i>6.94e-08</i>
Positive	<i>-7.00E-03</i>	<i>-1.752</i>	<i>0.0811</i>			
Clustered	<i>0.008</i>	<i>-1.504</i>	<i>0.14</i>			

N.B. Significance values of $p < 0.01$ are indicated in italics

5.6. Regional Breakdown of the Material Distribution

5.6.1. Areas 1 and 1E

The Nebulous Concept of Egri Bogaz 4

The above investigation of visibility has provided a framework for understanding the limitations of the landscape with respect to recovery, and an assessment of the biases that may influence the sherd distribution. While the intent of the survey was to avoid preconceived notions of archaeological sites, it is essential to first address the conventional interpretations of Egri Bogaz 4 before shifting back into a more distributional framework. According to the 2008 'Site Passport' document compiled by the Ministry of Culture, the actual site comprises a 1-1.5m high mound measuring approximately 0.1ha in area (Figure 51). A 50m protected zone around the site extends the total protected area to 1.7ha. These dimensions are most likely based on Udeumuradov's unpublished estimate of 1-2 ha, although he has said that the size of the site may change significantly with the shifting sands (B. Udeumuradov, pers. comm.). The discrepancy between the official estimate and Udeumuradov's assessment is likely due to the fact that the official estimate pertains only to the small mounded area immediately south of the road, and does not take into account the significant sherd scatters beyond this specific area. It is worth noting that, contrary to the findings of both Udeumuradov and the AMMD researchers, no mention is made in the government document of any threat posed by the gas pipeline, and no utility work at all is indicated near the site. While it is possible that this omission may relate in part to political sensitivities, failure to mention this significant feature may confirm that the official designation of Egri Bogaz 4 pertains only to the mound. In either case, however, Turkmen estimates indicate a small site on par with similar estimates for Egri Bogaz 1, 2 and 3 (B. Udeumuradov, pers. comm.; see also similar descriptions in corresponding site passports). Compared with these findings, AMMD researchers have provided a very different assessment. While not published in detail, records in both the AMMD GIS system and the 1998 AMMD Preliminary Reports identify the site as a mound, approximately 5m in elevation, surrounded by a large flat region (Bondioli and Tosi 1998: Appendix: Catalogue of Sites). The overall area, according to an approximate estimation of the extent of the pottery scatter, comprises approximately 13 ha, a region cut through both by the road and gas pipeline.

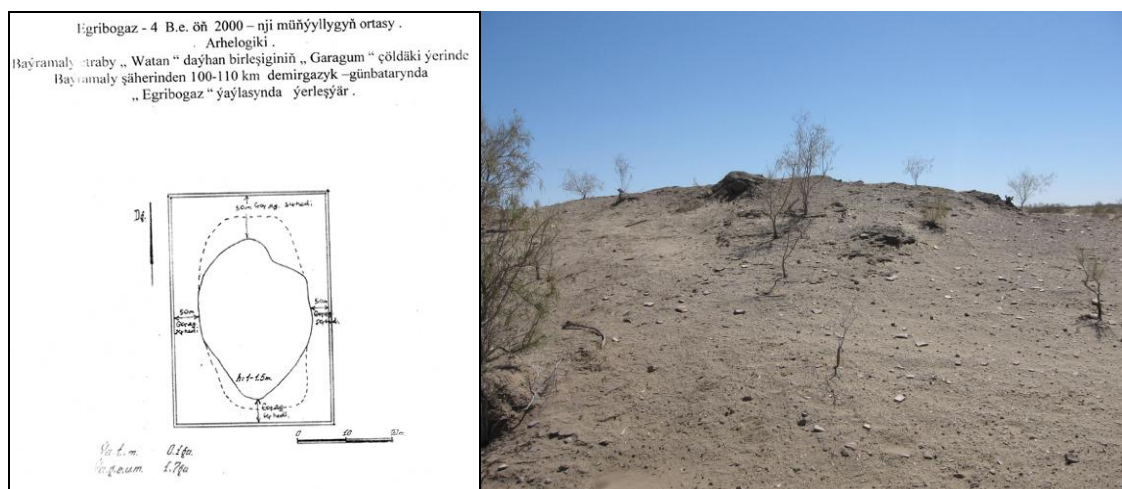


Figure 51. Perspectives of the site of Egri Bogaz 4. *Left:* Ministry of Culture Site Passport boundaries. *Right:* Photo of SE section of mound facing NW

The enormous discrepancy of these estimates illustrates the complexity of measuring the size of Egri Bogaz 4. Settlement size is a difficult topic in the Murghab (see also section 6.1), owing largely to the heavy and shifting obstruction of dunes which leave sites only partially visible on takyr edges (see examples in Sarianidi 1990: 10-13, 33-34). Gonur North offers perhaps the best example of such site discrepancies, where reported estimates range from just over 20ha to 50ha (Sarianidi 1990: 14; also see discussion in Kohl 1984: 143). In the northern Murghab, where dune cover is more substantial in places, such problems are exacerbated. Some degree of this complexity can be seen in a topographical map of Egri Bogaz 4 (Figure 52). A total-station survey, conducted as part of the current research, was conducted from the peak of the mound immediately south of the road and intended to explore the topographic variation over an area of approximately 1 hectare. At this scale, the complexity of the landscape is clearly evident, as wide topographical variation can be seen even within a 100m radius. The survey clearly shows two raised areas, one on either side of the road. Each of these rises approximately 4-4.5m from the surrounding takyr surface, although windblown sands impeded an exact delineation of each mound due to their integration with the surrounding sand ridges. While it is certainly possible that recent anthropogenic activity may have had some effect on the local topography, these two mounds appear to be distinct, indicating that the road cuts through a natural dip in the landscape. Both the northern and southern rises are similar in character, with significant quantities of pottery interspersed with windblown sands on the surface of each, although ground observations indicated that the density of pottery was slightly higher on the southern mound. Sherd densities actually appear to be significantly higher towards the base of the mound than on the surface,

although it is important to note that the fieldwalking survey was conducted at a lower resolution than the topographic survey of Egri Bogaz 4.

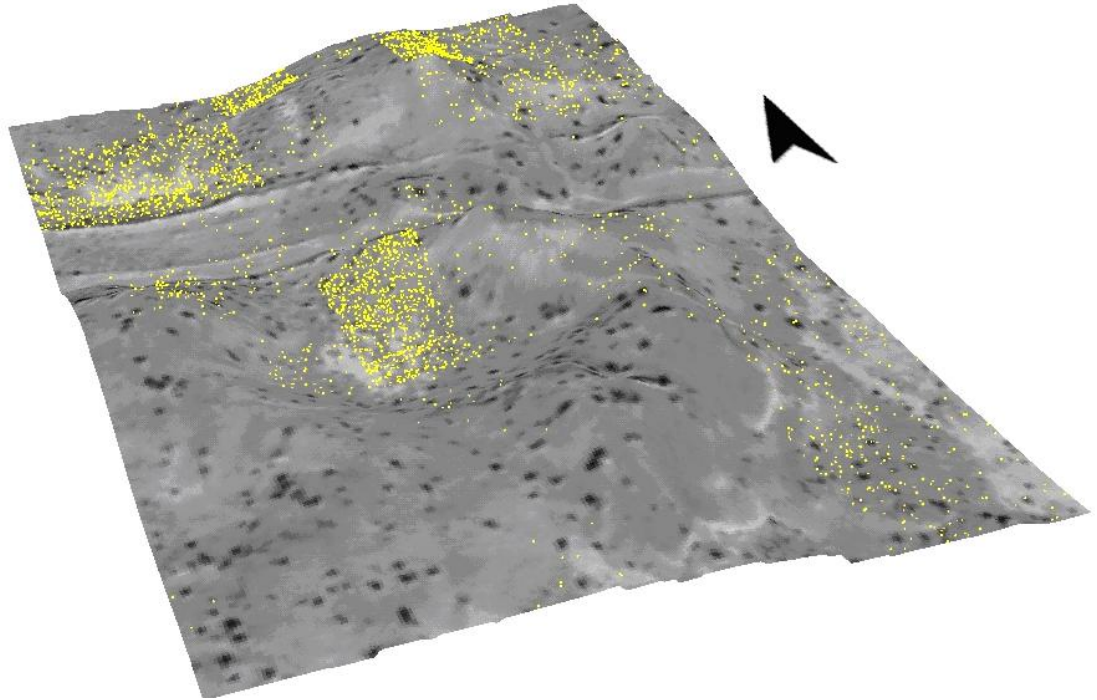


Figure 52. Topographic Map of Egri Bogaz 4 using Quickbird Panchromatic overlay. Points were acquired radially from surface of southern Egri Bogaz 4 mound. Areas in the corners of the image are consequently less reliable. Difference in elevation between takyr surface just west of the southern mound and the surface of the mound is approximately 5m. 1 dot = 2 sherds.

Other Previously Identified Sites in Area 1

In addition to Egri Bogaz 4, two additional Bronze Age sites were identified by AMMD researchers in the immediate vicinity (Figure 53). The first of these, designated AMMD 753, contained ‘Late Bronze’ and ‘medieval’ sherds (AMMD GIS), and is located immediately to the west of the primary sherd concentrations associated with Egri Bogaz 4. Field investigations confirmed the presence of surface sherds, some of which were found on an elevated sandy area. Again, however, the boundaries of these mounds were heavily obscured by substantial dune cover, and depositions of recent windblown sands further complicated the picture. Due in part to the proximity of these materials to Egri Bogaz 4, only about 200m away, as well as the obstructed visibility of each of these sites, it is questionable whether AMMD 753 should be classed as a separate entity at all. There was little evidence to indicate that the raised area was an independent archaeological feature distinguishable from the ridges in the landscape, and

densities were not particularly high compared to the widely distributed material in the vicinity. There is some evidence, however, that a channel may have run just west of Egri Bogaz 4 (see maps in Cremaschi 1998), a possibility that will be explored more in Chapter 7. While not definitively located, it is possible that material a few hundred metres west of Egri Bogaz 4 may represent occupation on the west rather than the east bank of a palaeochannel, and Cattani and Salvatori (2008: 13) have postulated a similar settlement pattern for Yaz III sites further south where houses may have existed along both banks of the channel, leaving the more outlying regions available for agriculture. Such a possibility, however, is only speculative and would require excavation of both sites and watercourses to confirm.

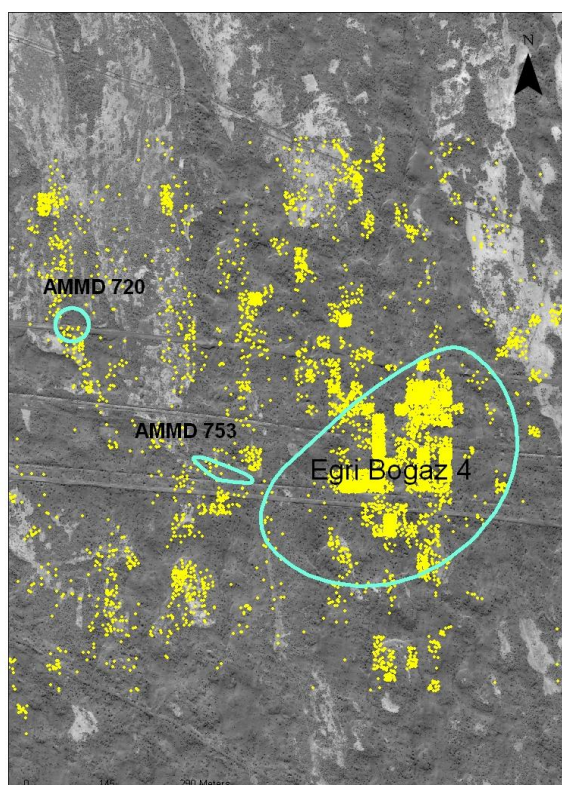


Figure 53. NMDS material distribution in the Egri Bogaz 4 region (1 dot = 2 sherds). Also shown are sites 720 and 753 as recorded by the AMMD researchers.).

The second site designated by the AMMD researchers, AMMD 720, was a more discrete entity located 500m to the northwest of Egri Bogaz 4. Its designation as a site, however, appears to be based primarily on widely spaced spot-checks along a transect connecting Egri Bogaz 4 and Kelleli 1, although AMMD researchers have recorded a sand-covered mound (Cattani and Salvatori 2008: 18). According to the AMMD findings, all three sites contained ‘middle and late

bronze age' material; with more 'cookwares' identified at these two peripheral sites (see comments in AMMD GIS system).

Material Distribution in the Central Portion of Area 1

Near Egri Bogaz 4 itself, significant quantities of over 100 sherds per collection unit occurred in several areas near the mound just south of the road, and a much larger region of even higher density is evident to the north. Before looking more closely at the distribution, a potential bias must be noted. It is likely that the pipeline construction unearthed a disproportionate amount of artefactual material. While such a significant bias may be expected to affect sherd densities, several factors suggest that the findings, although perhaps skewed, are still useful. First, the impact area of the pipeline is limited. A draft report by the Asian Development Bank (2005) suggests that severe disruption of the soil from a single derrick would be less than 4 ha. Since there is no direct drilling in the area, the affected region would most likely be less than 100m on either side of the pipeline. High ceramic densities beyond this range indicate that, despite the anomaly, the consistently high sherd counts are to be given serious consideration. Additionally, it is unlikely that the large sherds exposed from construction would have been displaced more than a few dozen metres from their origin. The presence of large diagnostics as well as small finds including a terra-cotta figurine of Namazga V type (Figure 51: also see Masson 1981: 92, Figure 27) and a bronze stamp seal (also see Section 5.11) further suggest that despite the biases that may result from modern activities, much of the area north of the road may have been heavily occupied. Further evidence of extensive occupation is indicated by the continued presence of small bits of copper and bronze in conjunction with surface scatters extending up to two kilometres north of the survey area where two additional north-south transects were conducted. Evidence of architectural remains, however, was unclear. The 'kiln remains' as observed by Udeumuradov (see above) were not evident as any individual structure. However, to the southeast of the main mound, immediately east of a 4m high sand ridge, was a heavy scatter of brick debris, some of it vitrified. There were also a few pieces of what appeared to be slag and although further analysis on these was not conducted, this may indicate local metallurgical production. With the exception of a small feature, possibly an oven, in the northwestern portion of Area 1 (see below), no obvious evidence of architectural remains was evident on the surface.



Figure 54. Namazga V type figurine recovered in Area 1

Distribution of Surface Material Beyond the Area 1 Main Concentration

Beyond these high-density regions, the surface material varied significantly over different parts of the landscape. West of the main scatters, sherd counts declined considerably (**Figure 55**). Approximately 100-200m beyond this low-density area, partially isolated patches of higher density are oriented approximately SW-NE, approximately following the edge of a takyr. The complex geomorphology in the area, however, may create false linearities that may not be indicative of the original settlement pattern (see section 6.5.1). This effect can clearly be seen in evenly spaced lines of higher ceramic densities oriented north-south, and are most likely associated with interdunar depressions. If the dunes were the only factor, however, the highest variation in sherd counts would be expected to be oriented perpendicularly to the dunes. It is therefore likely that other factors have contributed to the patterning, a prospect that will be examined more fully in the next chapter.

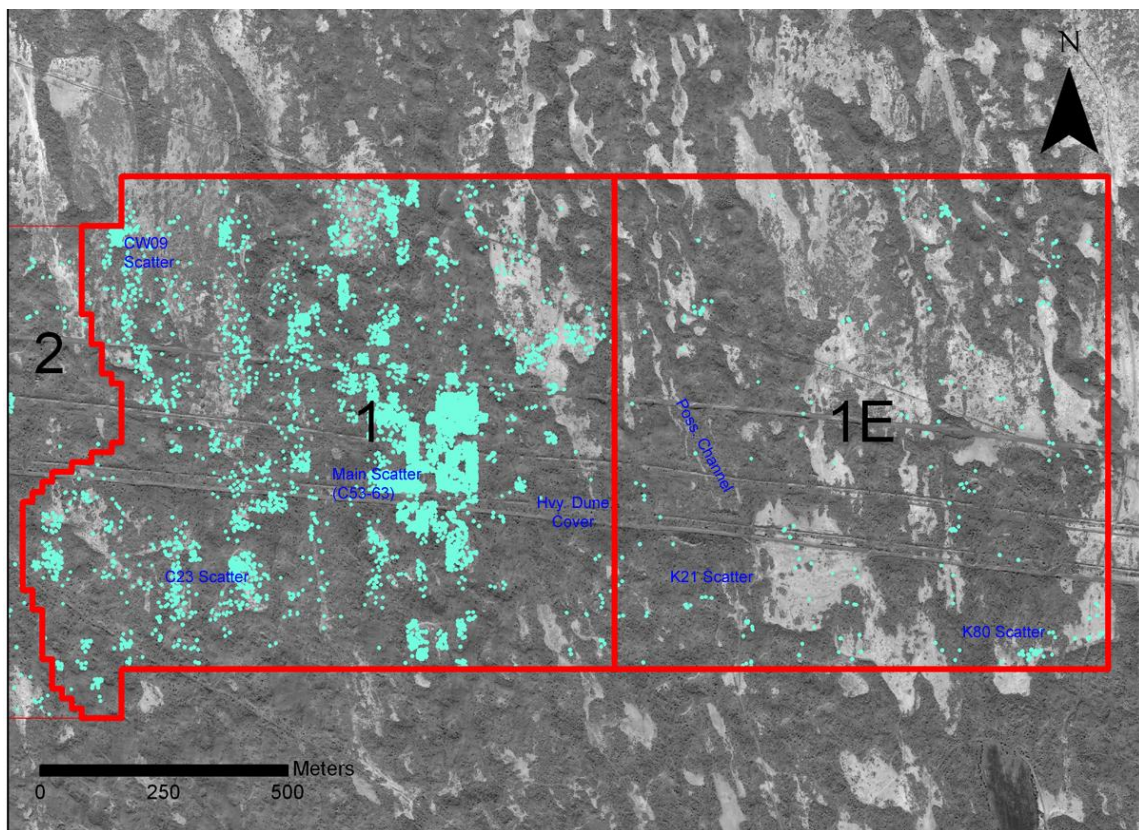


Figure 55. Area 1 and 1E Surface Distribution (1 dot=2 sherds)

In the northwest part of Area 1 (CW09), a large scatter of materials extended onto the surface of a takyr (Figure 56). On the takyr itself, a slightly darker area proved to be an area of ash that may be associated with the remains of an oven. Because of time constraints, the feature could not be examined in detail, although a cursory investigation indicated the presence of bricks a few centimetres below the surface, as well as charred remains of seeds. Although most of the pottery occurred on the surface of the takyr, the presence of sherds on a low rise immediately to the south of the takyr may indicate the existence of an anthropogenic mound. Pottery fragments in this area included two small lug handles, seen by both Hiebert (1994a: 50) and P'yankova (P'yankova 1993) as Namazga V diagnostics (Figure 57). Only five of these were found in the entire survey, four of which occurred several hundred metres to the northwest of Egri Bogaz 4. Hiebert associates these lugs with hole-mouth pots, linked with Period 1 (Kelleli-phase) material on Gonur as well as Kelleli 4 (P'yankova 1993; Hiebert 1994a: 50). Although any conclusion must remain purely speculative at this point, the presence of these handles in conjunction with the remains of an oven may offer some evidence for a Namazga V period domestic context significantly northwest of Egri Bogaz 4. Further support for domestic activity areas beyond the main depe may also be inferred from the higher density of blackened sherds in this periphery, presumably the result of cooking.



Figure 56. CW 09 Surface scatter



Figure 57. Probable Namazga V ‘Lug Handle’

The material found in Area 1 thus exhibited a significant degree of complexity, especially towards the west. In order to see if the patterning to the east exhibited similar characteristics, especially with respect to the secondary aggregations and linear patterning, an additional square kilometre was surveyed in May of 2009, designated Area 1E. Vegetation cover in the spring was much more substantial, covering nearly 20 percent of the surface in some areas compared to 5 percent or less in the autumn. Fully unvegetated takyr surfaces were rare, and vegetation commonly occurred in takyr cracks where sand had accumulated (cf Fleskins *et al.* 2007; Orlovsky *et al.* 2004). Nevertheless, visibility was generally high due to the large proportion of exposed takyr surfaces, and while the vegetation could be expected to decrease sherd counts to some extent, a visual assessment suggested that the obstructions were not significant. If anything, vegetation cover would therefore be more likely to affect the recovery of individual sherds rather than broader distributions of material.

The material distribution in Area 1E revealed a strikingly different character than in the western portion of Area 1. Beyond about 200m east of Egri Bogaz 4, sherd counts declined precipitously. Overall sherd densities in Area 1E were among the lowest in the survey area, and counts of more than 10 sherds per collection unit were extremely rare throughout the area. From a geomorphological perspective, the absence of material was surprising. Evidence of fluvial activity was common, and at least one meandering takyr feature contained several rounded, washed stones possibly indicative of a channel. Along this feature, partially obstructed by sand, a small cluster of small and medium sized sherds was found, although these offered little diagnostic evidence. These sherds were found within a small area of loose, fertile soils with bits of eroded material, characteristic of many of the low lying occupational areas. Several small, heavily abraded sherds occurred further north along this channel in K-21. While diagnostics in

this area were few and of poor quality, two small, heavily abraded rims suggest a Bronze Age date for this particular feature.

As elsewhere in the survey area, however, it was difficult to ascertain where concentrations of material necessarily indicated actual areas of occupation. The highest sherd densities in this particular region, for example, occurred in K-80, where a cluster of several dozen sherds spanned nearly 100m from east to west. These were generally small sherds, however, loosely scattered on an open takyr surface where visibility was high. The only collected sherd was a poor diagnostic, and it is likely that the material represents secondary deposition on the takyr, rather than any specific settlement. Ultimately, the overall pattern indicates an extremely limited occupation east of the main occupational region in Area 1, and any actual settlements in this region were likely extremely small. Despite this lack of occupation, however, the complexity of the takyr system suggests that this was a well watered and presumably fertile environment. Given the proximity of secondary watercourses to the main site, it is not out of the question to suggest that small-scale agriculture may have been practiced in these channels as well, possibly in the form of individual or community based irrigation projects that may have supplemented the bulk of the agricultural activity to the west (see discussion in section 7.7).

5.6.2. The Western Settlement Region: Area 4 and the Takyr Zone

A second occupational area, comprising much of Area 4, was clearly identifiable about 4km west of Egri Bogaz 4, with the majority of the sherd scatters visible on a large takyr measuring approximately 0.7km². The eastern edge of the takyr is well defined both in aerial photographs and satellite imagery, and ground observations confirmed that the clayey takyr surface transitioned fairly abruptly into low dunes. Evidence from both satellite imagery and test pits (see section 5.6) suggests that the eastern edge of the takyr may be loosely associated with a channel oriented north-south, and a long string of narrow, partially obstructed takyrs extending to the southwest towards Taip may offer evidence of a second channel (see section 7.7.2). The southwestern portion of the takyr was less pronounced. Significant takyr erosion and oversanding resulted in a more subtle transition into the dune landscape, and the sands facilitated significant vegetation in this region. Towards the north of Area 4, the road cut across the takyr, and the surface was traversed by numerous vehicle tracks. A utility ditch and associated debris were located in the northeast section.

Earlier research conducted in the mid-1990s revealed significant quantities of surface material in the region (Bondioli and Tosi 1998: Site Catalogue; Cattani and Salvatori 2008). Along the eastern edge of the takyr, the AMMD survey identified two previously unknown sites which they designated AMMD 717 and AMMD 718, both broadly dated to the Bronze Age (Figure 58). Both of these are classified as type ‘Depe 2’, denoting heavily eroded, shallow mounds of low elevation (Cattani and Genito 1998), although researchers have acknowledged that, in both cases, dunes may have heavily obstructed the main settlement area (Cattani and Salvatori 2008). NMDS field investigations confirmed a large pottery scatter on the takyr surface which appears to be the basis for the AMMD 717 site designation. However, while the surface elevation rose slightly towards the edge of the takyr, this appeared to be due to the sand ridge rather than any particular settlement mound, so the Depe 2 classification was questionable. High sherd densities occurred in a concentrated area, spanning about 100m from the edge of the dune ridge westward across the open takyr before abruptly ending. This pattern does not appear to be uniform however. To the immediate northwest of the scatter there is an area almost completely devoid of ceramic material. Southwards, material continuity was more evident, although densities were comparatively low and only two diagnostics occurred in this intermediate zone, which spanned about 400m from north to south.

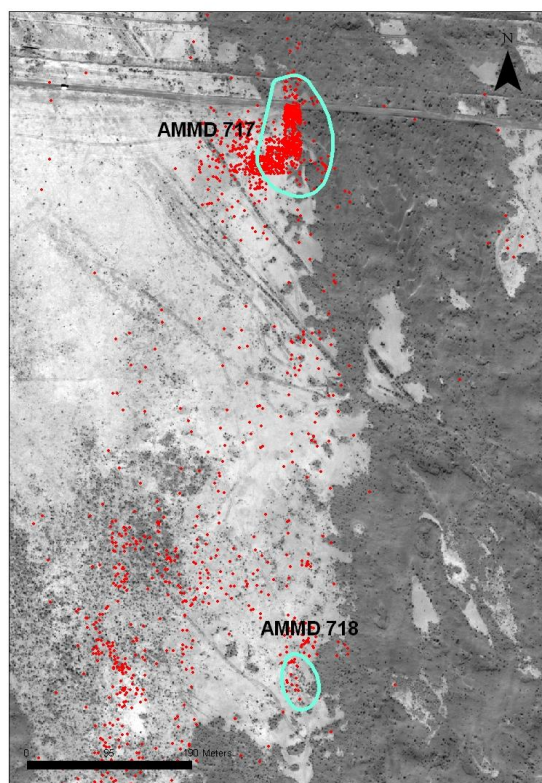


Figure 58. Sherd distributions on the Area 4 takyr. Sites designated by AMMD researchers are indicated in blue.

Confirmation of a specific location for the AMMD 718 site was difficult. This site is identified in the AMMD reports as a small *depe* measuring approximately 50m x 100m. Field observations, however, revealed a broad scatter of primarily eroded materials spanning several hectares of slightly varied topography, although the elevation anomalies were largely the result of takyr erosion and consequent oversanding. Surface material in the immediate vicinity of the AMMD site designation consisted primarily of small, heavily abraded materials widely dispersed across oversanded regions of the takyr and, as with the material just to the north, continuing onto the base of the dune ridge. This scatter represented the eastern extremity of a much larger area of material, including some traces of decayed brick further to the west that covered much of the southwestern periphery of the takyr. In total, the scatter measured roughly 7 ha, compared with a much more confined area of 2.5-3 ha for the northern scatter, and the heavy abrasion of much of the material in a region of widespread takyr erosion suggests that the distribution may indicate an occupational area severely impacted by deflation and consequent redeposition of surface material (see discussion of deflation in Rick 2002).

Another feature in this region that merits discussion is an area of green glazed sherds in the northeast part of the takyr. These sherds most likely date to the late Abbasid or early Seljuk periods (D. Gilbert, pers. comm.) and may reflect the small-scale reoccupation of the northern delta in later periods (Wright 2008). While the Islamic occupation of the delta is beyond the scope of this research, these finds are interesting in light of AMMD researchers' identification of an early Islamic site, AMMD 215, located slightly west of the survey area. The presence of green glazed sherds across the northern part of the survey area (see below) may indicate an east-west movement, and this possibility will be explored in more detail in Section 6.5. Moreover, green glazed sherds south of this region are interesting in light of Rossi-Osmida's discovery of early Islamic material from a 'burial' near Adjı Kui 1 (G. Rossi-Osmida, pers. comm.). The appearance of similar materials both in this portion of the central delta as well as in the survey area may offer some evidence of a broad north-south trajectory to the distribution of such material. While a detailed assessment of routes during the Islamic period is well beyond the scope of this study, it is possible that the presence of these materials may be associated with trade or communication routes extending northwards from Merv.

The absence of material in the far northwestern section of the survey area was striking, given the extremely high visibility afforded by the open takyr surface and high density of material on the southern and eastern takyr perimeter. Test pits, discussed in detail below, indicated an alluvial

character to the subsurface material, with laminar sandy deposits just below the takyr soils (see Lyapin 1991). The probable channel just east of the scatters and the evidence of complex fluvial activity suggest that fertile, alluvial soils were available in the vicinity, and the paucity of material west of the occupied area may indicate a largely unoccupied zone available for agriculture, perhaps in a manner similar to Area 1E, described above. However, despite the recent re-interpretation of the Bronze Age delta as a generally fertile environment (section 2.4.2), the actual extent of cultivable soils remains unknown, and it is quite possible that the availability of such soils was significantly reduced here at the distal portion of the delta, where encroaching sandy deposits, perhaps not yet widespread, may have restricted agricultural potential (see discussion in sections 7.8-7.9). If this is the case, agricultural land for these relatively small sites may have been largely restricted to the channels, enhanced by small transverse canals (cf Sherratt 1980). Another possibility is that more remote regions may have been available for pasture. Sherratt has suggested that, in the transition from proto-urban to urban Mesopotamia, the management of available pasture may have undergone a change from family-based subsistence herding to a more communal structure, where community-managed herds occupied a 'specialised pastoral sector in the interstices of the irrigated land' (Sherratt 1983: 99). Hiebert, while not addressing this potential distinction between subsistence and communal herds, has suggested that a restrictive dune morphology, while restricting agriculture beyond the cleared tugai vegetation along channels, may have offered substantial pasture land further afield, facilitated by ample saxaul vegetation in dune areas (Hiebert 1994b). Without further investigation, however, it is difficult to determine with conviction the specific scope and division of land use strategies.

5.6.3. The Intermediate Northern Zone—Areas 2 and 3

Between these two settlement areas, and spanning approximately 4km from west to east, was a comparatively flat region, characterised by intermittent dune hills and areas of exposed alluvium. The northern portion of this area was traversed by the road and pipeline, and parallel lines of upcast were visible both on the ground and in aerial photographs. As with Area 1, pottery was occasionally associated with this debris, although inflated sherd counts were not evident in the recorded sherd totals. While the evidence of fluvial activity was less prevalent in this region, numerous pockets of shell aggregations suggest that small channels may have existed here as well (see section 5.3), an assumption supported by the presence of the large takyr system immediately to the south traversed by a relict channel. In the eastern portion of the region, the

texture of much of the exposed takyr surface was soft and pliable, similar to the area north of Egri Bogaz 4, and dry, unvegetated surfaces were not particularly common, although these were more prevalent to the west. The qualitative difference between takyr soils may be partially attributable to the raised water table resulting from agricultural activities just south of the region. Additional evidence for a shallow water table may be found in a test pit conducted on the takyr surface north of Egri Bogaz 4 (see below), where salt was detected about 50cm below the friable takyr subsurface.

The agricultural zone, which overlapped the survey area in a few tracts (F30, G30-31), was characterised by recently ploughed cotton and wheat fields as well as heavily overgrown fields that had clearly fallen out of use. At least one relict channel appeared to have been incorporated into the modern irrigation system, and newer canals were clearly visible on the ground as square-cut channels alongside the eroded banks of older Soviet-era canals (M. Hojamma'ew, pers. comm.). Only the northeastern section of the takyr remained uncultivated, although the surface appears to have been cleared for further agricultural development (cf Fleskins *et al.* 2007). One feature worth noting was a densely vegetated depression measuring approximately 80m in diameter, and situated immediately to the south of a line of three wells. Fleskins (2007) has described an innovative system of water collection called a *chirle* in which a series of wells is used to extract fresh groundwater trapped between the sandy subsurface and salinated water below the lens. Usually, these reach a diameter of 10-12m, and it is perhaps more likely that the depression is, at least in part, natural. However, the presence of Sasanian and Islamic sherds, the line of wells, and the focus of the region as a newly developing agricultural zone suggest a history of significant water collection, and it is possible that the region once functioned as a primary source of water for caravans moving across the northern delta.

Surface materials in the region consisted primarily of low density scatters, with occasional areas of moderate density (Figure 59). Diagnostic materials were much more evenly distributed between earlier and later periods. Of the 48 inventoried diagnostics, about half were classified as post-Iron Age, with 20 representing glazed materials from the early Islamic period. Of the Bronze Age ceramics, it was not possible to ascertain fine chronologies for most of those found in Area 2. One probable Middle Bronze lug handle (see above) was found towards the east of Area 2 in H59. Although found in an isolated context, this sherd may be associated with a concentration of materials 200m to the east in C08, where another, similar lug handle was located. Other Bronze Age materials typically consisted of coarse, blackened sherds, often distributed widely around the perimeter of small takyrs. Although it was not possible to pinpoint

with accuracy the exact location of settlements based on a few scatters such as these, it is reasonable to assume that, given the tendency of these materials to occur together at significant distances from the area of central occupation, there is an actual cultural element to the distribution of these sherds that is probably not explained by post-depositional processes alone. One possibility may be that at least some of these scatters represent small-scale areas of domestic activity or, given the lack of architectural material in these scatters, possibly seasonal or periodic occupations (see Section 7.4.1). Such an idea has been put forth by Cattani and Salvatori (2008) to explain small scatters not associated with anthropogenic mounds, and there may be merit to the possibility. However, the direct association of a few sherds with a seasonal presence must be treated with suspicion given the complexity of the post-depositional processes in the northern Murghab. What does seem to be clear, however, is that the nature of occupation in these more remote regions has a significantly different character from the high-density regions not only in terms of the amount of surface material, but also in quality and type.

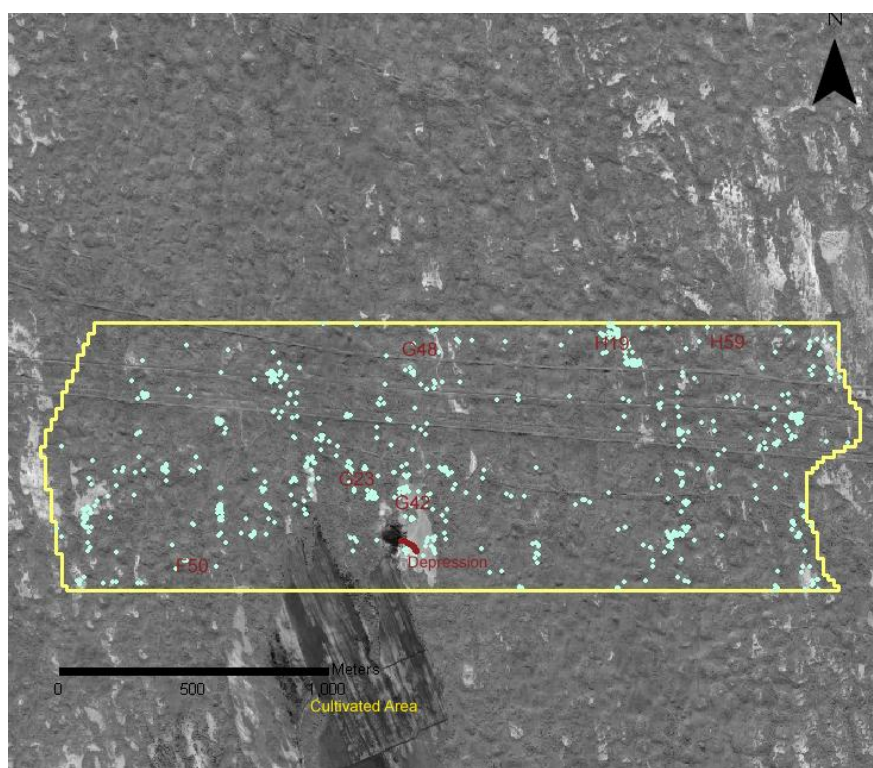


Figure 59. Area 2 Surface Distribution (1 dot = 2 sherds)

In the central portion of Area 2, Bronze Age diagnostics were uncommon. Worth noting, however, was a pedestal base, regularly found at many Margiana sites (Hiebert 1994a: 46-47) but the only one of its kind in the survey area. There was, however, significant evidence of later

occupation, evidenced by several glazed sherds as well as thick body fragments with a whitish-yellow fabric of a type commonly found at Merv (author's personal observation). While non-diagnostic with respect to finer chronologies, the fabrics are typical of Sasanian and Islamic period ceramics throughout the Merv oasis (G. Puschnigg, pers. comm.). Several of these materials occurred on or near an elevated sandy area in the centre of the takyr in G42. Although no traces of architecture were found, the presence of a brick 50m to the northeast is worth noting, as are several fired brick fragments associated with two significant sherd groups in tracts G23 and G24, all of which appear datable to the Sasanian or Islamic periods. These sherd clusters occurred in sandy depressions, and the presence of several small red sherds, heavily weathered, should be noted. An additional find worth mentioning was a possible Middle Bronze rim in F50, resembling Hiebert's 'simple rim bowl' category, one of the few rim types that occurs only in Period 1 in the Gonur North sounding (Hiebert 1994a: 47). Again, though, while the recurrence of such materials may offer evidence of Middle Bronze occupation in the region, it is not possible to definitively assign a chronology to this particular location based on a single diagnostic.

An additional area with traces of later occupation occurred in the northern part of the survey area in G48 and G49, partially comprising an elevated sandy region. One noteworthy find in this area was a scatter of a dozen sherds with a yellow glazed interior, presumably from the same vessel and assigned a single inventory number. Immediately to the south, the base of a large vessel with a black interior glaze was recovered. Although similar green and black glazed pottery occurred throughout the survey area, the presence of fragments of two large vessels in the same general area may be indicative of a more substantial presence. As was the case with the Islamic period finds, however, architectural evidence on the surface was absent, so it is difficult to say with certainty whether these materials may be associated with small caravanserais or waystations. The size of the vessels, however, suggests they may have been for stationary rather than mobile use (D. Gilbert, pers. comm.), a possibility that may find support in the brick evidence cited above. Moreover, the number of vessels of similar form, albeit usually unglazed, may offer evidence of a similar trajectory of small-scale occupation, both short-term and mobile, from at least as early as the Sasanian period well into the Islamic period. In addition to the vessels described above, several Sasanian body sherds with a wavy, combed incision occurred in this area. These also occurred in the western part of the survey area (see below), and the appearance of this type of pottery is noteworthy in its similarity to two sherds of similar type recovered from the surface of Adjı Kui 8 during the first year of the NMDS project. The similar distribution of Islamic materials has been noted above, and it may be that the presence of

Sasanian and Islamic materials both in the survey area and further south indicate a persistent north-south trading corridor. However, as a large area south of Area 2 remained unsurveyed, more research is necessary to determine actual broader-scale distributions of material.

In the western portion of the region, clearly identifiable Bronze Age material was sparse, and almost completely absent in Area 3, where overall sherd densities measured a scant 0.02 sherds/100m². The percentage of collection units containing material was extremely low, at only 0.89% in Area 3, and significant aggregations of over 5 sherds per collection unit were nearly non-existent, although one cluster of green glazed sherds occurred along the road. Diagnostics in the western portion of Area 2 and throughout Area 3 usually occurred singly, and were often not clearly associated with any significant artefact clusters. The increased sand cover in this region partially contributed to the absence of material, as suggested by the immediate cessation of the takyr surface scatters in between Area 3 and Area 4 which coincided with a large dune ridge. With the exception of this sand ridge, however, much of Area 3 exhibited high visibility, as nearly a third of the area was comprised of open takyr. Aside from the glazed Islamic sherds, diagnostics occurred singly and in low density regions, and consequently were difficult to associate with specific settlement areas. The occasional green glazed sherds are probably associated with broader, but highly dispersed, aggregations of similar materials on the large takyr to the west. Ultimately, there is very little evidence for substantial Bronze Age occupation in this area, although test pits revealing cultural material on the eastern boundary of Area 4 suggest that limited occupation may simply be obscured (see section 5.6.).

The character of surface scatters in the northwestern portion of this region (Figure 60) may offer some insight into the nature of 'background scatter' in the survey area (Bintliff and Snodgrass 1988). Raw sherd counts in Area 3 were 35 times lower than those just to the west in Area 4, a figure that dropped only slightly when the proportion of positive collection units are considered, and the number of collection units containing 5 or more sherds was 18 times fewer in Area 3 than in Area 4. The immediate and nearly complete cessation of material to the east of the takyr is markedly different than the behaviour in occupied parts of the Egri Bogaz region, although some parallel may be seen in the dune obstruction in both regions. While recovery bias was certainly an issue, it is likely that the influence of the Area 4 sites on the surrounding landscape was comparatively limited, although it is possible that small sites associated with the larger Area 4 occupations may have existed further to the east and have simply not been detected.

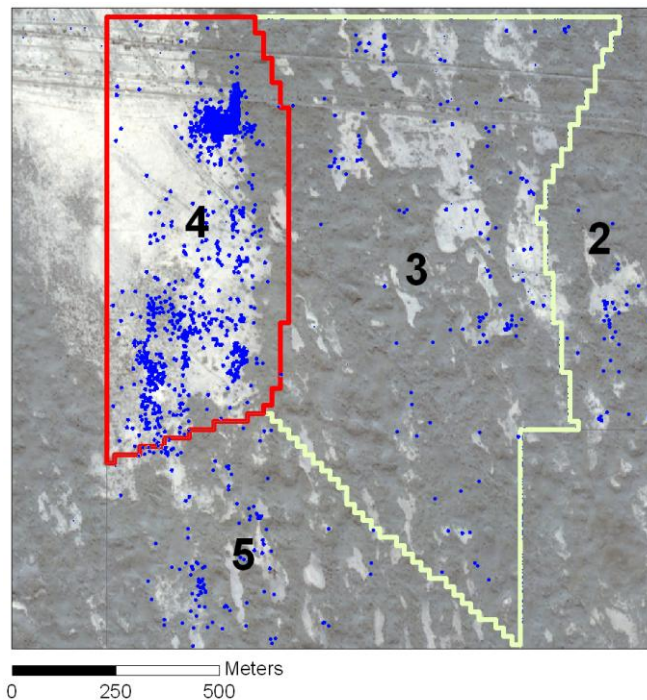


Figure 60. Northwestern Portion of Survey Area (1 dot = 2 sherds)

5.6.4. The Western Survey Region: Areas 5-7

The western portion of the survey area, with the exception of Area 8, comprised a region extending 3km south from the large takyr in Area 4 (Figure 61). The landscape was, as elsewhere, highly variable, although two broad geomorphological categories could be identified. To the west, much of the region was characterised by stable or semi-stable dunes. These were largely characterised by a gently rolling topography, and vegetation, while sparse, was widespread with low grasses and saxaul bushes. Small, occasionally oversanded takyrs were common but intermittent, and the line between aeolian deposition and exposed takyr surface was often very distinct, indicative of recent windblown sands rather than takyr erosion. The eastern half of the region was markedly different. Here, surface visibility was higher due to a system of long, linear takyrs, generally unvegetated, that may represent a southern extension of the large Area 3-4 takyr complex. Remote sensing imagery as well as field observations indicated the presence of one or more channels in the region (see section 7.7), primarily in the eastern portion of this zone, and it is probable that the morphology of the takyr system is largely related to fluvial activity in antiquity.

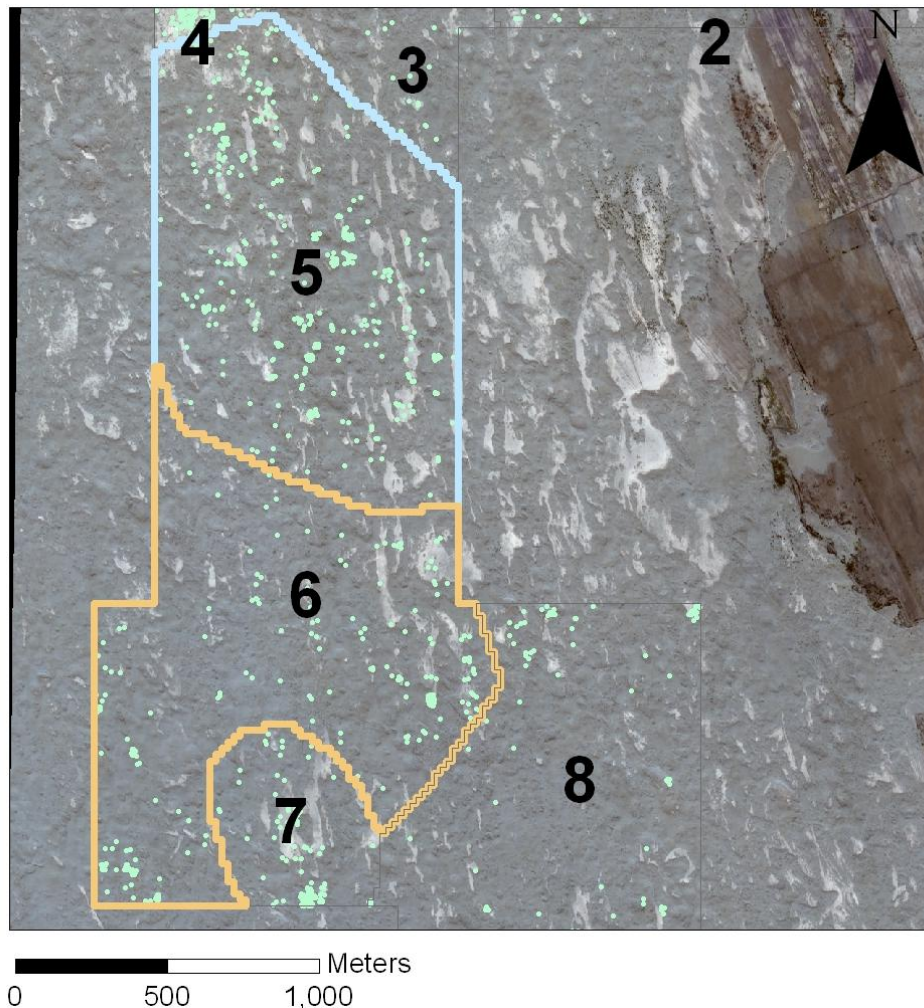


Figure 61. The Western Survey Area—Areas 5-7 (1 dot = 2 sherds)

Sherd densities in Area 5 were close to the mean for the entire survey area, at $0.05/100\text{m}^2$, a density broadly comparable with the central part of Area 2. The substantial sherd densities are explained in part by several moderate scatters spread over a fairly wide region south of the Area 4 takyr. The northernmost of these scatters, at L25, contained primarily Middle and Late Bronze Age materials (Figure 62). These were typically small and heavily eroded, and may be indicative of deflationary processes. Alternatively, the smallest fragmented materials may suggest aeolian processes involved in post-depositional scatter, where the smallest sherds were carried south by the prevailing winds. Dunnell and Stein (1989) have discussed the transportation of ‘microartefacts’ via aeolian processes, and evidence in the field was noted in section 5.3. While he caps this category at 2mm, the occasional appearance of heavily abraded, sub-centimetre artefacts in wind-deposited contexts (e.g. active dune slopes) throughout the NMDS survey area suggests that extremely small artefacts may indeed be subject to wind

transport, although this is unlikely to be a significant factor in the final deposition of larger sherds. Moreover, the presence of brick debris in conjunction with the materials in this region indicates that the deposition was probably associated with local occupation.

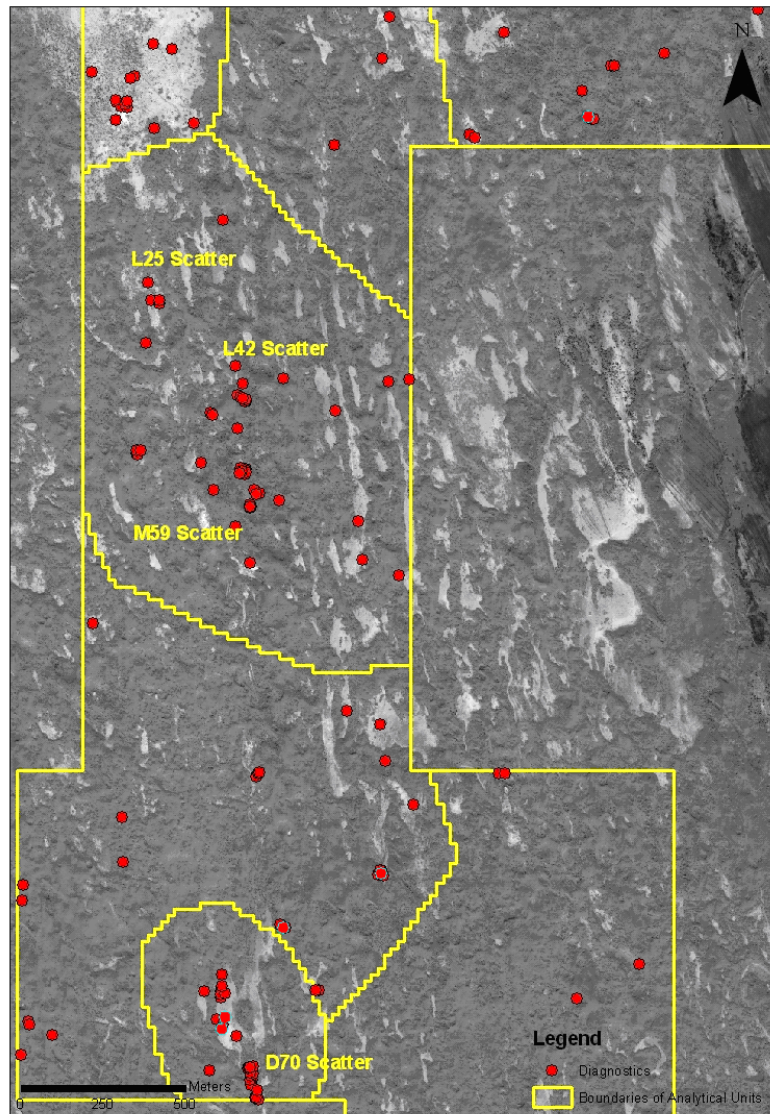


Figure 62. Key Bronze Age Scatters in Western Survey Area (red dots indicate diagnostic materials)

Another concentration of Bronze Age material occurred slightly to the south, centred near L42. Within these tracts was a moderate distribution of material, of which several collection units within a 100m radius contained 5 or more individual sherds. The diagnostics in this particular area have both Namazga V and VI characteristics, and the presence of a female terra-cotta figurine similar to the one found near Egri Bogaz 4 is worth noting as it offers strong material

evidence for the Namazga V period (see section 5.11). Compared with the broad scatter of small, eroded fragments immediately to the north, these sherds are larger, and a few late-period materials were found in the area as well. The Bronze Age materials were similar to those throughout the survey area and may indicate a substantial occupation in the immediate vicinity. If this is the case, establishing the boundary between this settlement area and the one to the north is difficult, since small scale ceramic scatters continue almost uninterrupted in the intermediate region. A third high-density area occurred about 300m further south, in M59. Here, again, sherds could not easily be broken down into specific Middle or Late Bronze chronologies. This broad assemblage comprised three separate aggregations each about 50-75m apart, each of which was located in a depression where the takyr surface was partially exposed.

As in Area 2, Sasanian and early Islamic sherds were common, and several large base fragments were found in this area. Architectural evidence directly associated with these distributions was absent, with one major exception well to the south in D70 which will be addressed below. While possible indications of mobility between Merv and the northern delta have been addressed, it is also possible that these assemblages are reflective of a more permanent occupation of the northern delta. Such a possibility may be supported by the possible discovery of a tomb from the 'Nestorian' period, loosely corresponding to the Late Sasanian/Early Islamic period, near Adjı Kui 1 (Casellato *et al.* 2007: Rossi-Osmida, pers. comm.). While such a find may indicate a more permanent presence in the north-central delta at this time, these findings are currently unpublished, and the lack of solid architectural evidence of waystations or caravanserais renders such a possibility merely speculative.

Bordering Area 5 to the south, the landscape in Area 6 was similar, although the rolling dune cover became more consistent and the takyr surface less obstructed. The overall sherd density decreased towards the south and while surface material remained nominally continuous, it was sparsely distributed, with densities measuring only 0.03 sherds/100m². The landscape, while remote and relatively undisturbed, was not completely free from anthropogenic activity, and occasional flat sandy expanses appear to be used for grazing, as evidenced by large fields of sheep dung that sometimes covered more than a hectare. Wind-blown sands were intermittent, sometimes occurring on hill slopes. The 'discontinuous bush' noted by Cremaschi (1998: 16), clearly characterised the vegetation here, consisting primarily of low grasses and saxaul, although areas of denser vegetation sometimes coincided with the edges of larger takyrs, possibly resulting of higher moisture content along these lower-lying areas. Interspersed amongst the dunes were takyrs ranging from two or three metres to over 100m across, and

artefactual material tended to cluster in small sandy depressions or over-sanded takyr although significant sherd concentrations were rare, with only 4% of collection units containing material. Large, open takyr were almost completely devoid of significant material concentrations, although a few sherds were occasionally found at the takyr edges.

The southern part of this region designated Area 7, comprised a small area where both geomorphology and surface distribution were distinctive with respect to the surrounding landscape (Figure 65). It was dominated by a substantial takyr complex covering 5 or 6 ha and evidence of nearby fluvial activity may be seen in the myriad of narrow, meandering takyr features in the area as well as the resurgence of a widespread distribution of shells primarily to the east of the takyr complex. The surface scatter here was substantially higher than in the southern portion of Area 6, although the problem of modifiable aerial units (MAUP) discussed in Chapter 2 certainly must be taken into account given the small size of Area 7. Two features stand out and merit further discussion. The first consisted of two mounds at the northern edge of the takyr complex. Each mound was roughly circular, less than 20m in diameter, and densely covered with fired and vitrified brick debris (Figure 63). On the northeast mound four partially buried bricks may indicate the remains of a kiln. One unbroken brick (Figure 64) had dimensions of 31x31x6 cm, significantly different from the size range (approx. 40x20x12cm) attested for most Bronze Age bricks (Rossi-Osmida 2004; Sarianidi 1990). The takyr in the immediate vicinity was almost completely devoid of sherds, and no diagnostic material was recovered. The presence of green and black glazed sherds a few hundred meters to the south, as well as the brick size, may indicate a small presence in the area during the Abbasid or Seljuk periods. In the centre of the takyr, several dozen metres to the south east of the brick deposit, was a large, sandy mound, found in the satellite imagery to be spectrally similar to the larger archaeological sites in the central delta. Investigations of this feature, however, yielded no archaeological material except for a few late-period sherds around the base. The nature of the brick scatter is puzzling, largely due to the lack of pottery, but a Bronze Age date for the site is questionable on several counts. First, Bronze Age kiln sites tend to be associated with fairly substantial ceramic scatters and debris, as observed in the partially excavated kilns on Egri Bogaz 1 and 2 and possibly supported by the substantial brick scatters in Area 1. The extremely low ceramic density casts doubt on the presence of pottery kilns on the site. Moreover, the size of the few fired bricks was different from the standard Bronze Age bricks, as noted above. A third issue, albeit a highly speculative one, concerns a striking linear feature that traversed the western part of the takyr. While field examination indicated that the feature was a sand ridge, Sarianidi's (1990: 55) contention that ridges may form atop raised canal banks may suggest that

the ridge may mask an obstructed channel. If this feature is actually a canal, it may offer some explanation for the isolated location of these brick mounds. One possibility is that the feature was a kiln used specifically for water management. The use of bricks in the construction of sluices for the automatic regulation of water has been attested in inscriptions at the site of Diqdiqah, between Ur and Larsa (Jacobsen 1960), and texts at Lagash have documented the use of fired bricks in the construction of small dams to raise the water level in canals (Tamburrino 2010). It is also possible, however, that such features post-date the Bronze Age, and similar features are known elsewhere in the region (D. Gilbert, pers. comm.).



Figure 63. 'Kiln Site', facing west



Figure 64. Brick from 'kiln site'

A second significant distribution of materials occurred a few hundred metres to the south in D70 (Figure 65). Several high-density collection units in this area were recorded during the survey, and a brief reconnaissance a few dozen metres south of the survey area showed that the scatter continued at moderate density although a major centre of occupation was not discovered. Sherd counts in this region were comparable to the broad clusters in Area 5, and the fairly broad spread of the surface material after a significant drop-off in Area 6 indicates a resumption of occupation in this particular area. Unfortunately, as with the aggregations further north, it was difficult to date the material specifically to the Namazga V or VI period and evidence of both appear in the surface assemblage (Figure 66). Later materials were largely absent from these materials although sporadic occurrences were noted. Unfortunately, the full extent of the distribution was not determined as it extended substantially beyond the survey area. The proximity to an apparent divergence in the palaeochannel system is worth noting, however (see section 7.7), and it is quite possible that the material in D70 represents the northern extent of a substantial Bronze Age occupation.

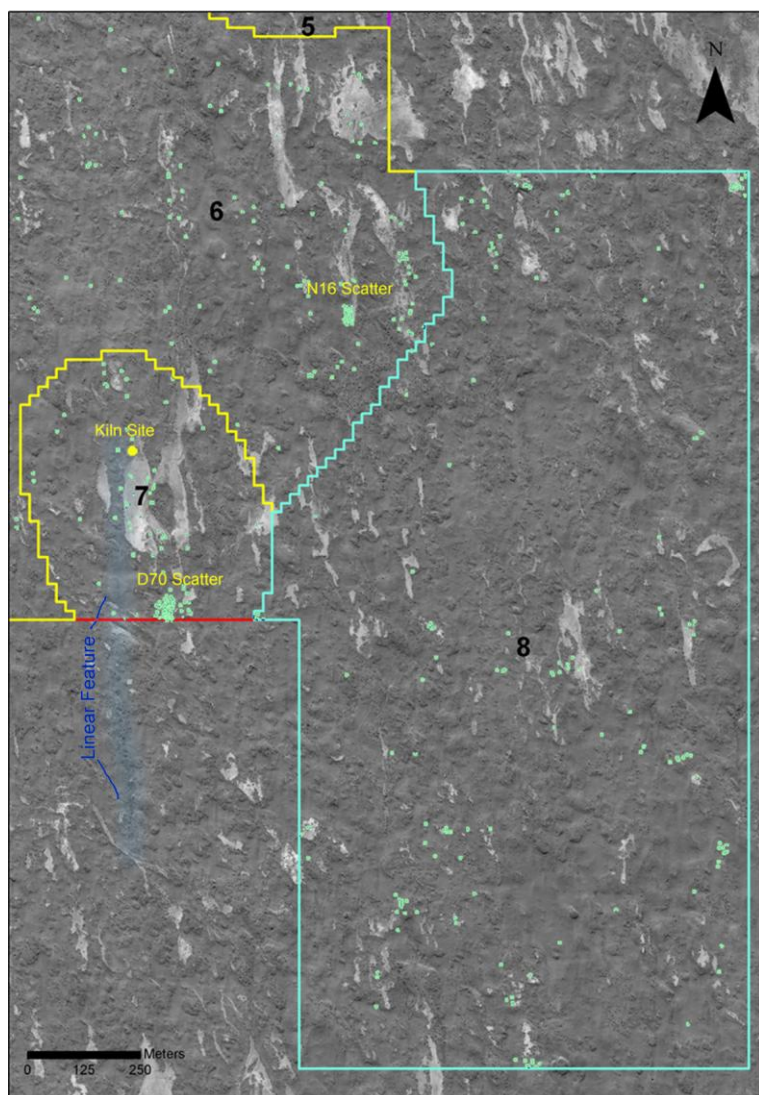


Figure 65. Area 7 and Area 8 Surface Distribution (1 dot = 2 sherds). Note the linear feature, highlighted in blue, leading northward from a possible SE-NW orientated channel and bypassing the ‘kiln site’ immediately to the west.

5.6.5. The Backcountry: Area 8

Area 8, a broad but remote region comprising the southern extent of the survey area, was located about 3 km south of the road. Perhaps more than any other portion of the survey area, Area 8

represented a conventionally 'off-site' location, situated in the middle of the desert several kilometres from the broad surface scatters in Areas 1 and 4. The landscape here consisted largely of rolling, semi-stable dunes, again with the occasional presence of recent windblown sands. Areas of exposed takyr surfaces occurred sporadically in the region and the broad takyr surfaces to the north and west were much less common in this region. Where these did occur, they were typically very small, often on the order of 10-20m in diameter or less. The hallmarks of fluvial activity that were apparent elsewhere were much less prevalent in this part of the landscape, and it is possible that in some cases many of the takyr-like soils and sandy depressions may not be associated with the alluvial surface prior to the encroachment of sand dunes. Fleskins (2007: 20) has observed that certain takyr-like formations may result from the trapping of water from sheet-wash episodes, resulting in oval-shaped takyrs that occur in 'zones of sandy hillocks and vegetated sands'. He distinguishes these from those associated with the Pleistocene or early Holocene fluvial activity, although he notes that these two types of takyr may co-occur.

This geomorphological environment most likely accounted for the extreme paucity of sherds in Area 8, where densities measured only $0.015/100\text{m}^2$, the lowest in the survey area and slightly less than in the similarly obstructed part of Area 3. Sherd concentrations and particularly clusters of over 5 sherds per collection unit were extremely rare. Of these particular concentrations, one is worth mentioning. This was a moderately dense, and fairly isolated, scatter at the southern edge of a linear takyr in N16, measuring approximately 50m x 20m. The presence of several sherds partially buried in the surrounding sands offered some evidence of actual occupation, but there were no traces of architectural remains or brick debris and it is equally plausible that many of these sherds eroded onto the takyr surface.

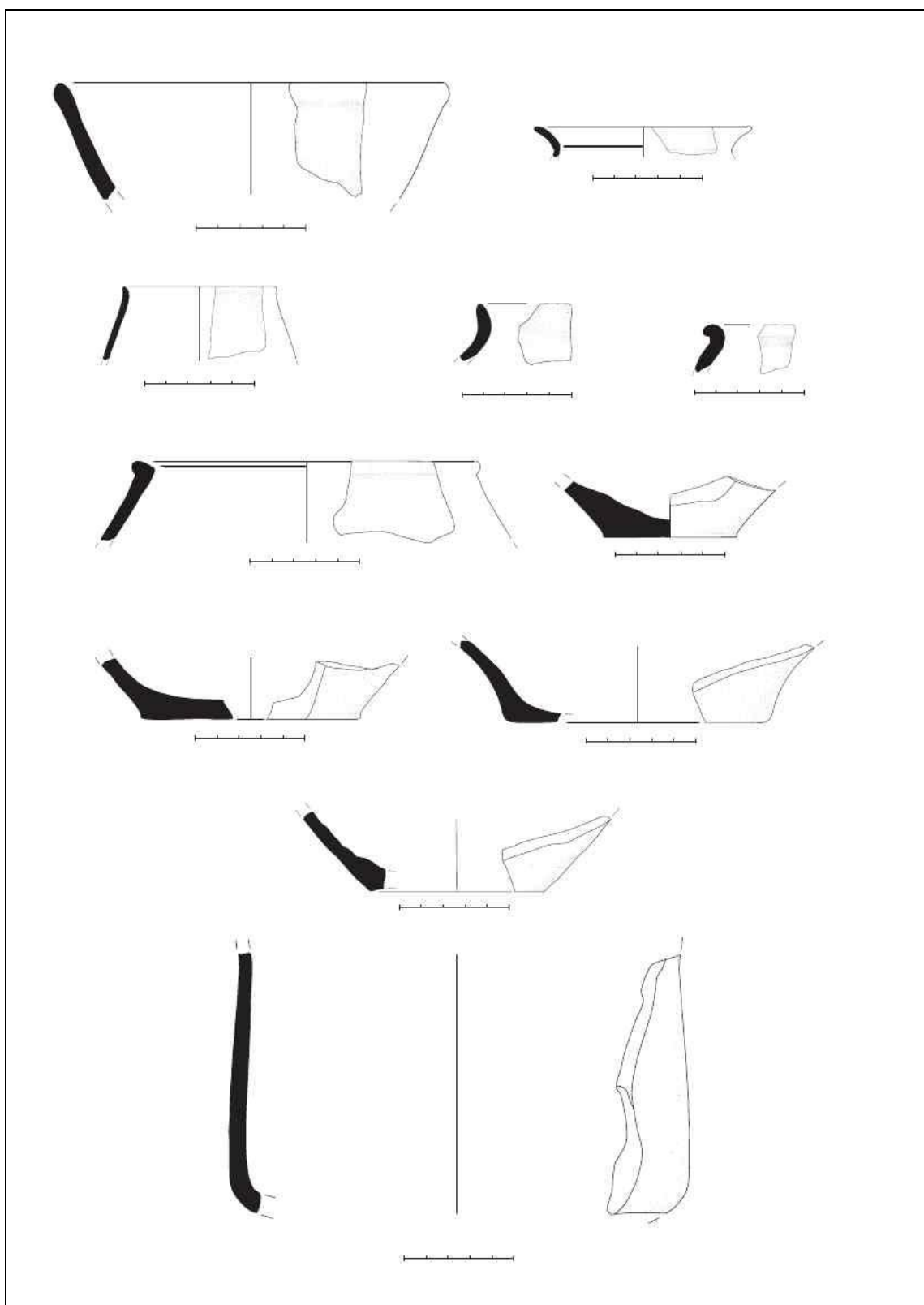


Figure 66. Surface sherds from Area 7 (D70)
 (Drawings by Denitsa Nenova. Reprinted with permission.)

5.7. Subsurface Analysis

The above analysis has clearly shown the extent of variability in the NMDS survey area, and suggests that the actual settlement landscape was far more complex than might be indicated solely from the identification of a few sites over a broad region. However, four millennia is an extremely long time, and it is unreasonable to assume that the archaeological landscape has remained static. In order to test the degree to which the surface distribution accurately represented actual occupation, several test pits were conducted in areas where, based on the extent of material scatter, subsurface archaeology was deemed likely to have occurred. Due to time and resources, these were limited, and only meant to represent a sample of the kind of subsurface deposits that characterised the Egri Bogaz 4 region as well the more restricted surface scatters in Area 4.

5.7.1. Area 4 Test Pits

The first series of test pits was centred just south of the road on the large takyr in Area 4 (Figure 67). The initial test pit, located within the AMMD 717 site boundary, was centred in an area of high ceramic density on the takyr surface immediately west of a dune ridge of about 2m in height. From here, additional pits, spaced 40m apart, extended both east and west to cover both dunes and takyr. Measurements taken with a theodolite indicated that the topographic variation on the takyr was minimal, although a 2 cm decrease in elevation towards the east may be indicative of a slight west to east slope. The two test pits placed directly on the takyr surface revealed natural stratigraphy, devoid of cultural material. Sediments associated with the takyr, on the order of 10-20 cm deep, appeared to be predominantly friable clay. Fine, laminar sands occurred below this layer, and below 50 or 60 cm a more compact, a sand/clay layer was encountered. This secondary clay layer is interesting in light of Lyapin's findings in the Kelleli 1 area, in which he posits that a subsurface layer of dense clay immediately below a layer of laminar sands may correspond to the Namazga II or III alluvial surface (Lyapin 1991). If this is the case, it supports the possibility that Bronze Age alluvial deposits are not very thick in the region, and that minimal subsurface investigation is sufficient to identify the extent of Bronze Age deposition. Another noteworthy observation was that the appearance of the sandy layer in TP 717-0 occurred nearly 20 cm below that of TP-717 1W, suggesting a downward grade to the east (Figure 69). Such a slope is interesting in light of the presence of the extensive linear chain

of takyr approximately 80m to the east, bounded by sand ridges, and it is plausible that this grade was related to a fluvial feature, which could account for the decreasing thickness of the takyr layer to the west. Cattani (2008c: 140, Figure 10.7) has observed similar behaviour in a natural channel near Takhirbai 3, and the implications of a watercourse in Area 4 will be discussed in detail in Section 7.7.

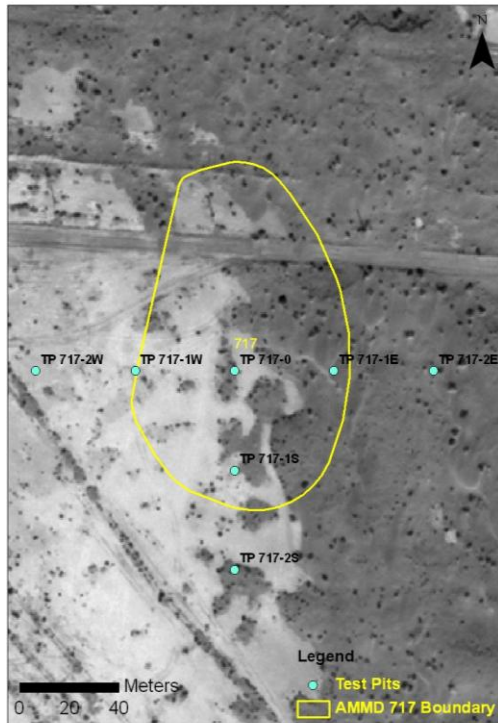


Figure 67. Area 4 Test Pits.
AMMD delineation of site 717 indicated in yellow.

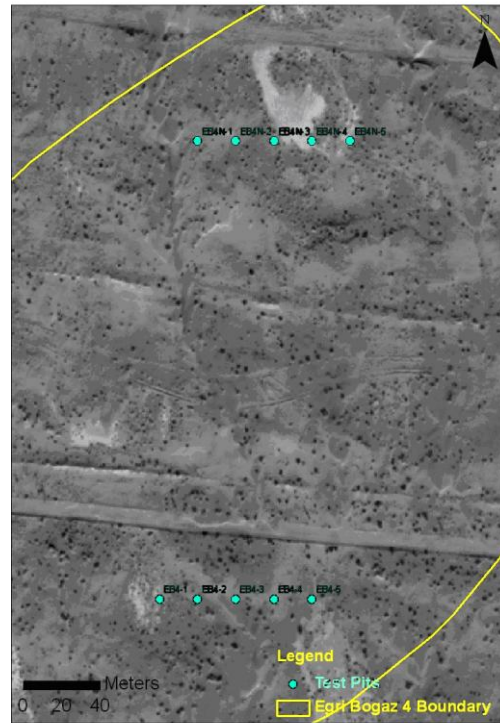


Figure 68. Area 1 Test Pits
AMMD delineation of Egri Bogaz 4 indicated in yellow

In order to test this possibility, an additional test pit, TP-717-2E, was dug in a fertile interdunar ‘valley’ on the east side of the dune ridge (Figure 70). Unlike in the sandy deposits on the western slope of the dune ridge, no cultural material was visible on the surface, and it appeared as if the depression could be the result of a natural formation of dune ridges. The test pit, however, revealed that the takyr surface was approximately 40cm lower than in TP-717-1E, indicating that the valley was most likely the result of underlying topographic variations and not the product of variable and more recent aeolian deposits. The clays in the takyr layer here were poorly sorted and coarse, possibly indicative of more active fluvial activity. Occurring throughout the level of takyr-associated sediments was a thick ash deposit, most pronounced in the western wall of the pit and more concentrated towards the bottom of the deposit. A few very

small sherds and possible brick debris, less than 1cm in diameter, were found along with bits of plaster, although no charcoal was recovered. Although the size of these sherds was similar to abraded fragments found in test pits conducted to the south (TP 717-1S and TP-717-2S), the sherds here were thicker and more intact which suggests that these were locally deposited sherds rather than debris carried via aeolian processes. Unlike the windblown material on the surface west of the ridge, it seems more likely that this material is directly associated with nearby occupation although it is quite possible that this specific deposition was the result of more confined erosional processes. A significant increase in the thickness of the ash deposit to the west, as well as the west-to-east grade mentioned above, suggests that actual settlement may have occurred on the alluvium quite close to the watercourse, although the occupational area is now mostly covered by dunes (Figure 71). Two additional test pits excavated within 10m of TP-717-2E failed to reveal a continuation of the deposit, although sparse evidence of plaster occurred in these pits as well.

Test pits were then extended to the south, again at 40m spacing, where the open takyr gave way to low, over-sanded regions with varying degrees of cultural material on the surface. While it was unclear whether or not these slightly raised areas accounted for the 'Depe 2' designation in the AMMD reports, the concentrations of pottery initially appeared to offer a promising sample although the surface sherds were heavily abraded. The situation in these test pits was substantially different. The sandy surface layer was interspersed with large numbers of tiny, heavily abraded and angular sherds, usually less than 1cm in diameter. The top layer of TP-717-2S also contained charred seeds, although no evidence of scorching or ash was present, and the seeds were similar to those found throughout the survey area and may indicate wind-carried seeds from more recent fires. While the exact takyr horizon was not easily detectable below the sand, possibly complicated by pedoturbation processes (see Leigh *et al.* 2001), the cultural material was confined to the upper 10-20 cm, terminating around the sand-takyr horizon. Successive strata, typically sandy but with progressively higher clay content, yielded no cultural material in either of these two test pits.



Figure 69. Test Pit 717-0 (facing north)



Figure 70. Test Pit 717-2E (facing west)

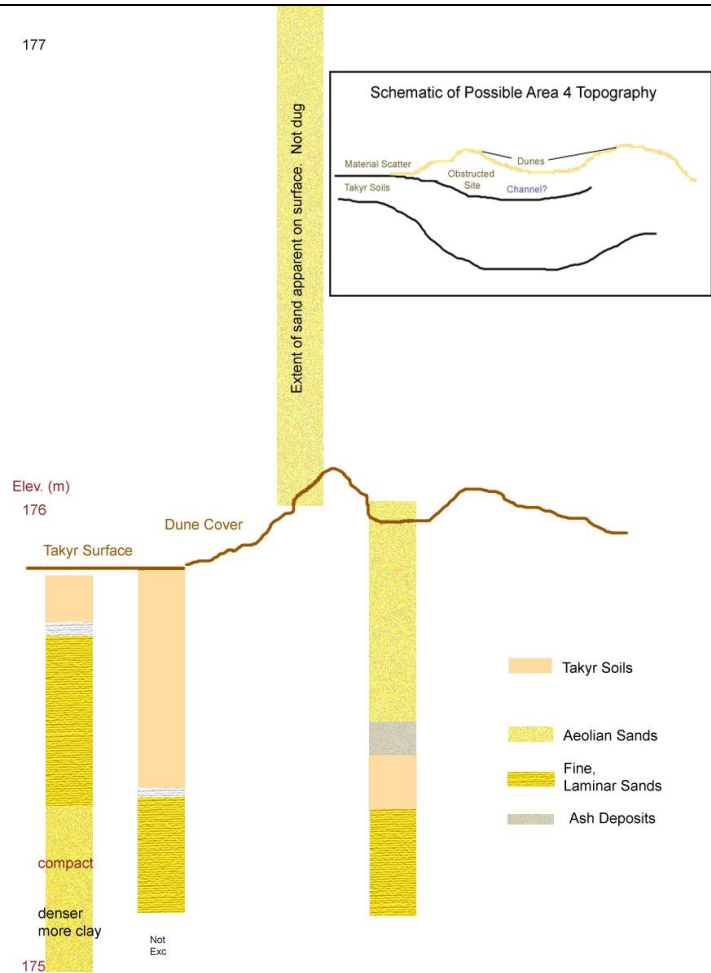


Figure 71. Schematic diagram of Area 4 test pits and topography

An additional series of test pits in Area 4 was conducted about 300m to the south of the region just described, and extended west from the centre of the estimated boundary of AMMD 718. The takyr surface in this part of Area 4 was slightly more uneven and oversanded, although elevations were not recorded for this particular series of test pits. The profile of all three of these test pits was similar, although with some variation. Takyr-like soils typically extended to 15-20 cm below the surface, below which a layer of fine laminar sands was reached. In TP-118-1E, a secondary layer of clayey deposits occurred above a second sand layer, again presenting evidence of Lyapin's posited buried alluvial surface (see above). No cultural material was found in any of the trial pits, including one placed 120m to the west in another region of moderate surface scatter, so it was not possible to draw any substantive conclusions about the actual archaeology on the southern part of the takyr.

Table 14: Area 4 Test Pits (vicinity of AMMD 717)

Test Pit 717-2E	
0-40 cm	Generally fine dune sands. Clumpy quality to the soils
40-50cm	Fine, ashy layer, gradually broadening towards the west edge of the pit. Occasional bits of plaster and small ceramic and brick fragments.
50-80cm	Fine, laminar sands likely associated with alluvial
80-108cm	(auger) continuation of fine, sandy sediments
108-120cm	secondary, compacted clay layer

Test Pit 717-1E	
0-35 cm	Dug on a dune surface. Fine, loose sandy deposit. Too fine to auger

Test Pit 717-0	
0-45 cm	Takyr sediments. Blocky, crumbly material.
45-55cm	Very fine greyish sands, indicative of alluvial deposits (Lyapin 1991)
50-75cm	Fine, laminar sands. Yellowish-brown. Excavation abandoned at 75cm

Test Pit 717-1W	
0-40 cm	Takyr sediments. Blocky, crumbly material.
40-50cm	Very fine greyish sands, indicative of alluvial deposits (Lyapin 1991)
50-100cm	Fine, laminar sands. Yellowish-brown

Test Pit 717-1S	
0-20 cm	Windblown dune sands, very small, heavily abraded fragments (>45)
20-40cm	Takyr sediments. Blocky, crumbly material. Cultural material continues with over 50 fragments. Similar quality as upper strat but slightly larger fragments
40cm-70cm	Fine, laminar sands. Yellowish-brown

Test Pit 717-2S	
0-20 cm	Windblown dune sands, very small, heavily abraded fragments (>50)
20-40cm	Takyr sediments. Blocky, crumbly material. Cultural material ends, but one vertical rim, probably MBA, appears at the boundary of this level and the sandy layer.
40cm-70cm	Fine, laminar sands. Yellowish-brown

5.7.2. Area 1 Test Pits

A second region of subsurface analysis was conducted in Area 1, again traversing the topography in an east-west direction. The first of these lines consisted of several test pits spanning the conventional Egri Bogaz 4 mound (see section 5.6.1) as well as a large depression to the immediate west. An additional line of excavations was situated 300m to the north in an area of heavy and continuous material scatters. Each of these lines was situated at least 75m from the pipeline in order to reduce the possibility of subsurface complexities from recent activity. Given the proximity to the main site and the consequent potential for a clearer understanding of the erosional processes acting on the depe itself, the spacing between these pits was reduced to 20m, again on an east to west line, with two additional pits located in a region of heavy brick concentration to the south east of the site. TP-EB4-3, the only excavation conducted on the depe itself, yielded a single sandy layer to nearly 1.5m, almost devoid of cultural material despite a rich presence of artefacts, including some diagnostic material, on the surface. Adjacent test pits conducted on or just above the takyr surface immediately adjacent to the depe revealed small, eroded fragments intermixed with the surface sands. One exception was TP-EB4-1, which was dug directly into the surface of a vegetated and slightly eroded takyr and revealed several small sherds within the takyr clays, although these were restricted to within 10cm of the surface.

The northern line of test pits in Area 1 likewise comprised significant topographic variation, rising approximately 2m in elevation from takyr to dune ridge. Of the four test pits conducted, TP-EB4N-2, situated on the edge of the ridge, was by far the richest in cultural material, with a substantial quantity of brick fragments and small pottery fragments. While some of the small, abraded fragments appeared to have been deposited through aeolian processes as elsewhere in the survey area, the mixed nature of the deposit and substantial size of several of the fragments suggests that, while the final deposition may not directly reflect the original distribution, it is quite likely reflective of significant nearby occupation. Of the two test pits conducted on the takyr surface, a small amount of cultural material was present in the top layer of both of these which may indicate deflationary activity. Additionally, the presence of a smooth, washed stone in the top layer of TP-EB4N-4, situated on a low-lying, but uneven, takyr surface, may be indicative of channel activity, and other, similar stones occurred along an apparent channel in Area 1E.

Table 15: Area 1 Test Pits

Egri Bogaz 4 Line (EB4 1-4)

Test Pit EB4-1	
0-50cm	Greyish brown takyr soils. Takyrs appear fairly well eroded on the surface, and soils are friable and crumbly in the immediate subsurface. Compaction increases below about 30cm and soil becomes nearly impenetrable. Cultural material in the first 10cm or so consists of small (<1cm) bits of brick and pottery.
50-60cm	(augered) continuation of extremely compact clay layer
60-69cm	Secondary layer of fine, laminar sands detected

Test Pit EB4-2	
0-40cm	Windblown dune sands. Similar quality as in Area 4. Substantial fragments, generally <1cm but 2 or 3 larger ones
40-50cm	Takyrs level reached. Cultural material not apparent
50-70cm	Secondary layer of fine, laminar sands detected
70cm-1m	Compact takyr soils. Friable, crumbly consistency

Test Pit EB4-3	
0-130cm	Test pit and auguring. All fine, wind-deposited sands. Substantial, but generally small, sherd fragments in first 10-20cm

Northern Test Pit Line (EB4N 1-4)

Test Pit EB 4N-1	
0-120cm	Dune sands, relatively uniform throughout layer. Cultural material, small (<1cm) fragments (about 20-30) and bits of plaster, appear at 80cm and continue through 120cm

Test Pit EB 4N-2	
0-120cm	Dune sands, similar to EB4N-1 but more clumped. Substantial cultural material (over 50 fragments), sometimes over 3cm occurs throughout strat.

Test Pit EB 4N-3	
0-20cm	Soft takyr sediments. Fine and adherent texture, almost silty. Small sherd fragments (about 25) and bits of plaster
20-45cm	Gradual change to fine sands, cultural material ends towards top of this level
45-60cm	Secondary clayey soils. Salt component. Few (4-5) fragments of brick or pottery
60-90cm	Fine, laminar sands

Test Pit EB4 N-4	
0-15cm	Soft takyr sediments. Fine and adherent texture, almost silty as above. Small sherd fragments (about 20) and one small (<1cm) piece of black chert. One washed stone
20-60cm	Fine sands, no cultural material.
45-60cm	Secondary clayey soils. Salt component. Excavation ended at 60cm

Despite the lack of clear evidence for substantial occupation layers in Area 1, these small excavations provided important information pertaining not only to the relationship between surface and subsurface distributions, but also to the underlying topography of the landscape. The locally variable but broadly uniform nature of the sediments below the takyr surfaces both in Area 4 and Area 1 suggest substantial complexity in a long sequence of alluvial events. The fairly shallow cultural material in the single positive test pit in Area 4 suggests that settlement should be detectable quite close to the ancient alluvial surface, a finding that is consistent with the shallow depth of material posited for the sites in both the Kelleli and Egri Bogaz regions (Udeumuradov 1993; Masimov and Kohl 1981). Since the material recovered from the pit was sparse and offered no diagnostic features, it cannot be said with absolute certainty that it reflects a Bronze Age horizon, although this seems to be the most likely scenario based on the surrounding material.

What the test pits ultimately offer is a set of both clues and restrictions on how to interpret the survey data. Clearly, the estimation of specific site dimensions and locations based on material scatter is extremely unreliable, a result of deflation and localised erosion, although fluvial erosion may also have played a role in antiquity (cf Brown 1997: 279). Additionally, although the evidence was very sporadic, artefacts beneath the sandy deposits exhibited a greater degree of preservation which suggests that deflationary processes may be substantial on the exposed takyr surfaces. At the same time, however, obvious cultural levels were largely absent with the exception of the single case in Area 4. In Area 1, small sherds both on the surface and in the top levels of the takyr clays offer weak evidence for definitive habitation. While deflation may well be at work, the absence of large subsurface sherds again suggests that much of the surface material is the result of secondary deposition, albeit most likely from a nearby origin. Of course, a few pits on a takyr offer only a tiny window into the subsurface archaeology, and it is quite possible that material has simply been missed, or that habitation was highly intermittent and the assumption of uniform occupation, even in densely settled areas, may not be accurate.

5.8. *NMDS Cultural Material*

5.8.1. General Characteristics of Diagnostic Material

Having set out the scope of the surface distribution and its relationship with the subsurface archaeology, the next phase of the analysis will assess the finds from a material and chronological perspective. During the course of the 3-year survey, a total of 707 inventory

numbers were assigned to diagnostic material, 620 of which could be broadly dated. Of these, 509 were classed as Bronze Age materials, with the rest falling into post-Iron Age categories. The Iron Age itself appears to be almost unrepresented, with the exception of a single painted Yaz I sherd, and an additional find near Egri Bogaz 4 with a possible Yaz III-type rim (see pottery descriptions in Bonora and Vidale 2008). These figures do not present the entire picture, however. Since most of the diagnostics were found in a concentrated section of Area 1, the finds in that particular region were heavily skewed towards Bronze Age materials. Diagnostics were much more evenly distributed beyond this region, and of the 215 diagnostics recovered in areas 2 through 8, 84 were classed as Sasanian or Islamic, while 90 fell into the Bronze Age category. These numbers are potentially misleading, however. Several dozen of these late-period sherds were glazed sherds or large, high-fired vessels from the Sasanian or early Islamic periods. In addition to their easy identification as diagnostics in the field, these fragments were far less susceptible to abrasion. Indeed, it was not uncommon to find an isolated green-glazed fragment among several non-diagnostic materials likely to date from the Bronze Age.

Although the finer details of the Middle and Late Bronze Age chronology are still not clearly understood, some observations may be made about the types and distributions of the ceramics. Materials found in the survey area were predominantly wheel-made, and represent a range of clearly identifiable Namazga-type materials. Forms consisted primarily of undecorated, open vessels. The near-total lack of decoration or other distinctive features suggests a primarily domestic assemblage, although a single sherd with a herringbone pattern, found immediately prior to the survey near Egri Bogaz 4, is worth noting (see Appendix 4). A number of fragments showed signs of blackening, suggestive of their use for cooking. Storage vessels, while present, were uncommon. Notably absent from the survey area were any indications of ceremonial vessels, e.g. decorated or spouted containers, such as those found at Gonur. Pedestal bases, which are common in the Namazga V necropolis at Gonur as well as in many of the Namazga VI sites (Hiebert 1994a: 67-71; Udeumuradov and Rossi-Osmida 2002), were almost entirely absent, and only a single base of this type was recovered in the entire survey area.

Most of the ceramics were comprised of a fine matrix with few if any apparent inclusions. Bronze Age sherds were undecorated, and fabrics ranged from a reddish or rose colour to white, often with a buff exterior. Darker red wares were less common and often heavily abraded. Although Hiebert (1994a: 40) suggests that darker red and red-slipped wares at Gonur become more prevalent from the Late Bronze Age into the Takhirbai period, the generally poor quality of these materials in the NMDS survey suggests that they may simply represent more exposed

fabrics, and Puschnigg has observed that fabrics of this colour occur in most periods in the Murghab (see Puschnigg 2006: 173, Fabric B3). Several sherds in Area 1 had a greenish hue, commonly associated with the Namazga V period in excavated contexts (Hiebert 1994a: 67), but discolouration from salts or other chemical processes is also possible in these exposed contexts (B. Sillar, pers. comm.). Less common in the survey area were grey or brown wares which P'yankova and Hiebert have suggested originate during the Namazga VI or later periods (Hiebert 1994a; P'yankova 1993). Preservation was varied, and abrasion resulting from wind-blown sands resulted in a grainy exterior surface on most of the materials which made it extremely difficult to identify external surface treatments such as slips or burnishing. Later materials, often high-fired vessels from the Sasanian and early Islamic periods, were generally less susceptible to erosion, and surface decoration, usually green or black internal or external glaze, were often largely intact. Another category of material that occurred throughout the survey area was coarseware. This material was generally handmade, although wheel-thrown coarsewares are known in the Murghab (Hiebert 1994a: 61), and the poor quality of the materials found on the surface often masked the production method. Hiebert cautions that a distinction must be made between the incised coarsewares, associated with the steppe 'Andronovo' groups who inhabited the delta towards the end of the Bronze Age, and coarse domestic materials associated with sedentary sites of the Namazga V and VI periods (Hiebert 1994a: 69). The former, generally incised and comprising a coarse, greyish fabric, was rare in the survey area, and only one context containing steppe materials was definitively identified in Area 2. The latter group of coarsewares is represented in all periods of Murghab settlement (periods 1,2 and 3 in the 1989 Gonur sounding), although Hiebert has noted an increase in reddish-purple, grog-tempered fabrics in the Late Bronze Age (Hiebert 1994a: 61), a few of which were detected in the southwestern portion of the survey area (e.g. E-32). Bonora and Vidale (2008) have noted that coarsewares appear in the Yaz I period as well. However, these later materials are usually a buff-brown to grey colour, and the almost complete absence of the highly diagnostic painted wares that characterise the early Iron Age suggest that the coarsewares in the NMDS study area were most likely products of the sedentary occupants of the northern Murghab.

5.8.2. Diagnostics by the Numbers

To gain a sense of the distribution of these materials throughout the survey area, it is useful to assess briefly the quantity of diagnostic materials (Table 16). The use of diagnostics as a scientific measurement is, of course, problematic since the identification and collection of such materials in the field is extremely subjective (Mattingly *et al.* 2000). Nevertheless, the presence

of clearly identifiable rims or bases in one context compared to another may provide indirect information on the character of the distribution with respect to primary or secondary depositional contexts, and possibly even activity areas. In the survey area, Bronze Age diagnostics typically represented between 2 and 5 percent of the aggregate sherd totals. Bevan has suggested that this number is low compared to Aegean contexts, for example, where percentages of diagnostics (as defined according to comparable criteria) are often 10+% (A. Bevan, pers. comm.). Although different pottery traditions may partly explain these differences, it may also be that heavy abrasion (see below) has contributed to the low numbers. Additionally, as noted in Chapter 1, the desert climate is highly variable, and Taylor (2000) has suggested that severe freeze-thaw cycles may further increase fragmentation. A combination of these processes may have resulted in a much higher percentage of small, unidentifiable body fragments, ultimately reducing the proportion of identifiable diagnostic materials. A striking example may be seen in Area 4, where the diagnostic percentage was a minuscule 0.43%, the lowest in the survey area. Given that these numbers were recorded in an area of high visibility, it is likely that poor ceramic quality partially accounts for the lack of diagnostic material, and visual observation did reveal that materials in much of Area 4 were small and heavily abraded. The Area 4 numbers contrast significantly with those in the other zone of heavy occupation, Area 1, although the huge amount of surface material in this latter region most likely contributed to unreliable diagnostic percentages. While higher-quality, more clearly identifiable diagnostics may be more likely to occur in more complex or ‘urban’ areas, and while the pipeline excavations may have unearthed larger fragments, any potential increase was probably counteracted by the overwhelming sherd totals in the area. Ultimately the diagnostic counts in low to medium density areas are likely to be much more reliable than those in Area 1.

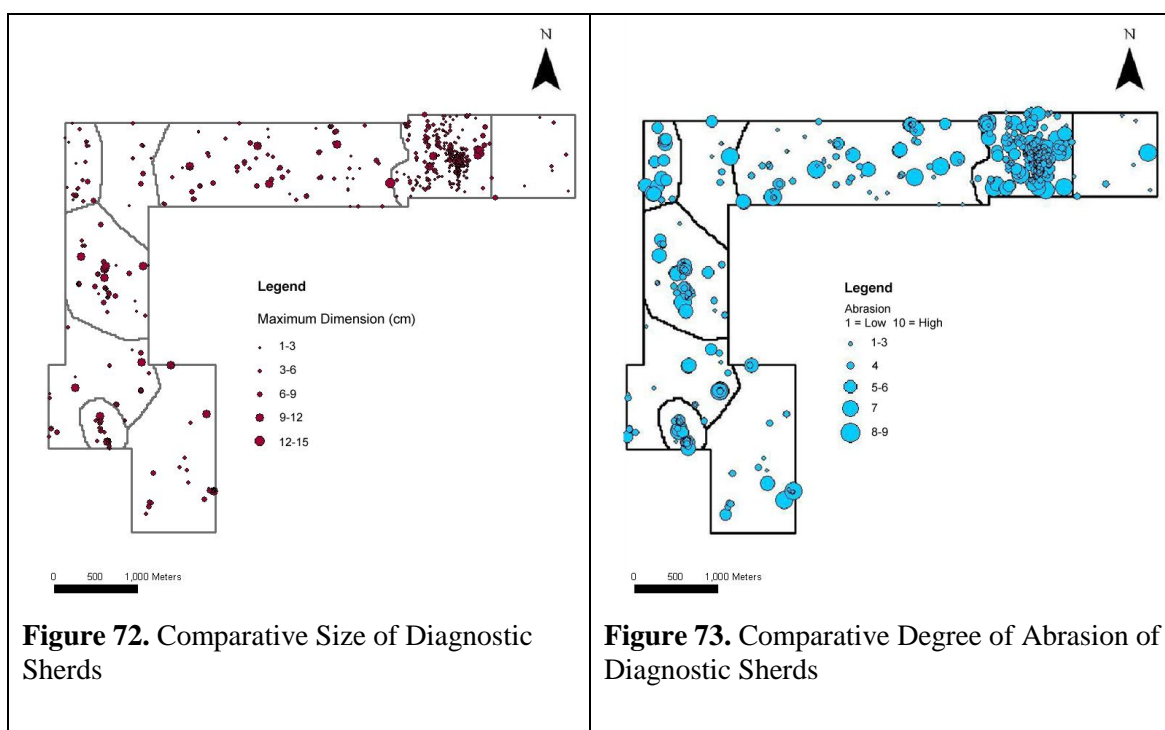
Table 16. Diagnostic Count by Analytical Unit

Analytical Unit	All Sherds	Bronze Age Diags	Diag %	Avg. Max. Dim. (cm)	Abrasion (1-10)
1E	380	3	0.79	5.64	2.66
1	15641	339	2.17	4.5	3.07
2	1187	37	3.12	6.04	3.03
3	187	2	1.07	5.33	2.36
4	3029	13	0.43	5	4.12
5	695	30	4.32	5.76	2.96
6	427	18	4.22	5.92	4.06
7	230	23	10	5.43	3.54
8	279	7	2.51	6.9	3.42

The figure consists of two histograms. The left histogram, titled 'Size', shows the distribution of sherd sizes in centimeters. The x-axis ranges from 1 to 15 cm, and the y-axis represents the count, ranging from 0 to 80. The distribution is unimodal and slightly right-skewed, with a peak count of approximately 75 for sherds between 4 and 5 cm. The right histogram, titled 'Surface Abrasion (1-10)', shows the distribution of surface abrasion levels. The x-axis ranges from 1 to 10, and the y-axis represents the count, ranging from 0 to 120. The distribution is also unimodal and slightly right-skewed, with a peak count of approximately 110 for an abrasion level of 3.

5.8.3. Abrasion and Size

Although diagnostics cannot be expected to offer an accurate representation of the full surface assemblage, these materials contain several useful characteristics that can offer insight into the nature of their deposition, of which size and abrasion will be briefly discussed here. It should be cautioned that sherd size is a complex issue and, as Orton (1993: 214) admonishes, fragmentation may vary widely amongst materials and contexts. In the NMDS survey, the largest fragments were often late-period, high-fired sherds with a maximum dimension often approaching 15cm for some of the thick bases, while green-glazed fragments tended to cluster around 5 or 6cm. Bronze Age sherds fell broadly within the 4cm to 6cm range, with some of the largest sherds occurring amid the dense surface scatters in Area 1. A visual assessment of the size distribution is shown in Figure 72. Larger sherds tended to occur in the more significant settlement areas, corresponding in part to the central Area 1 scatter as well as the probable occupational areas in Areas 5 and 7. The surprising preponderance of small sherds in Area 4 has been touched upon above, and may confirm that much of the Area 4 surface assemblage has been exposed to deflation, especially in the southern part of the large takyr, or may be the result of secondary deposition from the largely obstructed settlement area on the eastern edge of the takyr. Intermediate regions exhibited substantial variation in size. Isolated large fragments in the central portion of Area 2 may offer circumstantial evidence of local occupation, although it is reasonable to assume that small sites existed in the region. Whether or not these mixed sherds represent a larger individual settlement cannot be determined, although it should be mentioned that several non-diagnostic sherds were found on the periphery of the agricultural region immediately to the south, so a more significant occupation cannot be ruled out. In the more remote regions of Area 1E and Area 8, aggregates of large sherds were generally absent. While it is difficult to make any strong inferences about settlement from these diagnostics, the size data clearly support the general impression of these latter regions as peripheral to main areas of settlement activity.



A second aspect of these diagnostics that may provide some clues to their depositional characteristics is the degree of surface abrasion. This estimate was obtained via a visual assessment of the surface wear of 499 sherds conducted by the author over a two-day period, with abrasion estimates ranked from 1-10. While a simple regression of diagnostic percentage on sherd abrasion did not show a correlation ($r=0.2$, $p>0.5$), it is worth noting that the highest abrasion index occurred in Area 4, where diagnostic percentage was lowest. Other areas of the NMDS survey generally exhibited similar percentages of diagnostics and, with the exception of Area 3 where diagnostic materials were mostly green-glazed Islamic-period sherds, percentages in these 'offsite' regions were slightly higher than in high-density areas, probably due to the ease in identifying such materials in lower-density sherd scatters.

Figure 73 shows the degree of sherd abrasion throughout the survey area. The map clearly indicates some broad trajectories of abrasion that appear to be linked to site and material distribution. Perhaps the most apparent is a concentration of lightly abraded materials in Area 1, corresponding largely to the high-density area just north of the road. As noted, it is probable that the upcast from recent pipeline excavations contributed at least partially to the prevalence of higher-quality, better preserved materials. However, most of the large sherds in Area 1 had the same wind-abraded quality as did materials elsewhere in the survey area, which would likely be much less significant if it were merely the result of recent exposure. The large size of several of

these fragments, moreover, suggests that these materials were most likely not transported far from their original deposition area.

In Area 5, lightly abraded materials tended to aggregate over a 3-4 ha area associated with the L42 scatter mentioned above. However, since the sample size is so small, care must be taken in drawing significant conclusions about the distribution of a small quantity of sherds. Nonetheless, the apparent focal point of well-preserved material in a localised high-density area does suggest that, as in Area 1, the assemblage represents a locus of actual occupation. Confounding the interpretation, however, is the anomaly in Area 4, where the material was significantly smaller and more heavily abraded than elsewhere in the survey area (see above). Qualitatively, these kinds of fragments in Area 4 resembled those in some of the more remote sections of Area 1, both south and west of the main concentration (e.g. C22/23). Elsewhere in the survey area (e.g. F10), scatters occasionally exhibited similar characteristics, suggesting that similar processes may be in evidence.

In order to see if there was any apparent relationship between sherd abrasion and land type, a 2-sample paired t-test was conducted on the Bronze Age diagnostic material, comparing the mean abrasion values (see above) on sandy areas with those in the takyr zones, as identified by the classification algorithm defined in Chapter 4. For the entire survey area, the t-value yielded 0.28, well below the required significance levels, suggesting that land type did not significantly influence the degree of abrasion. It is quite possible, however, that the juxtaposition of uncertainties in actual sherd location as well as an oversimplified representation of the landscape masked the influence of landscape types at smaller scales. Ultimately, while these examinations of size and abrasion proved useful from a qualitative perspective and offered some sense of the nature of fragmentation and deposition, these data were less useful from a quantitative perspective.

5.9. *NMDS Chronologies*

5.9.1. Early Bronze Age (Namazga IV)

Over the entire 11 km² survey area, evidence of material culture pre-dating the Namazga V period was almost nonexistent. The only possible indication of any earlier activity was a single terracotta figurine base, found in the northwestern portion of Area 1 and similar to figurines

found in the Namazga II and III periods in the Geoksyur oasis (Figure 74). While it may be tempting to draw conclusions from this particular object, especially given the Namazga III surface materials in the Kelleli region (see section 1.8.4), there is little that can be ascertained from a single artefact. Any number of natural or processes, either ancient or recent, could be responsible for its ultimate place of deposition. The most that can be said is that the presence of a possible Chalcolithic figurine offers a slightly greater degree of support for the prospects of earlier settlement in the delta when considered in conjunction with the materials from Kelleli and the basal levels of Adji Kui 9 and Gonur (see section 2.3.1).



Figure 74. Terracotta Anthropomorphic Figurines, Possible Namazga II-III Type. *Left:* NMDS Survey Area, CW09. *Right:* Anthropomorphic Figurines from Geoksyur 1, late Namazga II-III (Kohl 1984: Plate 5a) (Reprinted with permission)

While the lack of early cultural material was somewhat disappointing from a discovery perspective, this absence is notable given the extent and intensity of the survey coverage in a region where alluvial deposition is substantially reduced (see section 1.8.4). While it is possible that undecorated material from the Namazga IV period was simply not recognised in the field, the easily-identifiable geometric motifs that characterise the period (Kohl 1984: Plate 9a) suggest that material, were it present in any significant quantity on the surface, would likely be recovered. Moreover, as noted in Chapter 2, the problems both of alluvial deposition and agricultural damage were potentially less of a factor here. The lack of Namazga IV and earlier material thus reflects the situation elsewhere in the delta, and supports the idea that earlier settlement in this area, if it existed, was relatively sparse. It is, of course, quite possible that earlier material could be found through excavation of the Egri Bogaz 4 site, and has been obscured by later occupation compounded by erosion of the later material. The complete

absence of such material, however, is suspect, especially considering that the depth of deposit is very shallow in most Murghab sites (Hiebert 1994a: 17). Even if alluviation were a factor, it is probable that a continuous occupation through the Namazga IV period into the Namazga V would leave some traces of its existence. Again, however, there is the confounding situation of the southern delta, where the complete lack of Middle Bronze surface material is almost certainly the result of alluvial deposition. The Namazga V materials in burials in Taghta-Bazaaar (Udeumuradov 1993), while not yet linked with any local settlement contexts, support the case for undetected activity in the southern region, as does the identification of a coarse sherd recovered from a natural cut south of Merv, addressed in section 2.3.1.

5.9.2. Middle Bronze Age (Namazga V)

As discussed elsewhere, the identification of purely Namazga V or Namazga VI materials, especially in surface scatters, can be extremely difficult. Nevertheless, the excavations that have been conducted in the central delta and at Kelleli, as well as the reference typologies in southern Turkmenistan, offer some vital insights into the material culture of the Namazga V period in the NMDS survey area. One of the clearest indicators of Middle Bronze presence in this area was a flat violin-shaped female figurine (Figure 75). This object, and one quite similar to it found in Area 5, are well-known forms both in the Murghab and Southern Turkmenistan during the Namazga V period (Masson 1988:92, 27). Perhaps most prominently, these items have been found in abundance in the Namazga V site of Adjı Kui 9 (Rossi-Osmida 2007), as well as other Middle Bronze contexts throughout the Murghab. Stylistically, there are distinct parallels between these and the Namazga V statuettes in southern Turkmenistan sites such as Altyn Depe, and a possible production centre for these objects has been attested during the same period at Ulug Depe (Lecomte 2006). These figurines vanish abruptly at the beginning of the Namazga VI horizon, and are absent in Late Bronze contexts in Bactria (Hiebert 1994a; Salvatori 2008a: 78). An additional small find that suggests a Namazga V presence was a copper or bronze seal, found near a clearly disturbed context just north of the road in Area 1. These are usually found in Namazga V contexts, and Salvatori posits a transition to stone seals during the Namazga VI period (Salvatori 2008a). Hiebert has also noted the presence of seal impressions on ceramics from the upper levels of Gonur North, although these were not recovered in the survey (Hiebert 1994a: 61).



Figure 75. Namazga V-type figurines from Area 1 and Area 5

The surface ceramics also provided distinctive evidence of Namazga V occupation. One of the commonly cited hallmarks of Namazga V pottery, especially at Namazga Depe itself but also in the Murghab, is a greenish exterior, although this feature can occasionally result from misfiring of the vessels (Hiebert 1994a). Fragments with this colouration did occur in the NMDS survey, primarily in the vicinity of Egri Bogaz 4. Of these, worth mentioning are bases with slightly inward-sloping walls, possibly similar to finds in the basal levels of Adjı Kui 9 (Salvatori 2002), chronologically associated with the Kelleli phase. Also indicative of Namazga V occupation were the lug handles noted above, which Hiebert (1994a: 50) associates with ‘hole-mouth pots’. In most of these fragments, only the handle remained, although one large sherd with the handle and an undifferentiated vertical rim was located near Egri Bogaz 4 after the survey, offering some confirmation of the vessel type, and similar vessels have been found at Kelleli 3 and 4 as well as in the earliest levels at Gonur (P’yankova 1993; Hiebert 1994a: 50). With the exception of this fragment and one handle in C-12, these handles were generally found in the far northwestern part of Area 1 and were not found elsewhere in the survey area. Beyond area 1, probable Namazga V pottery included plain-rim vessels, similar to the plain-rim bowls associated primarily with Phase 1 of the Gonur North sounding (Hiebert 1994a: 47). Similar rims with a slight eversion occurred throughout the survey area, although these rims are common to multiple phases of the Murghab Bronze Age and could not be securely dated. Interestingly, the vertical grooved rims, one of the signature Middle Bronze forms at both Gonur and Kelleli and commonly found in the Gonur necropolis (S. Salvatori, pers. comm.), were almost entirely absent in the survey area, and only one of these rim sherds was found immediately north of the Egri Bogaz 4 mound.

Common to many Namazga V vessels are spiral-shaped, string-cut marks on bases (S. Salvatori, pers. comm.) and these were prevalent throughout the survey area. This feature is widespread throughout Turkmenistan and well-known at sites such as Altyn Depe during the Namazga V period (Masson 1988). Although the process continues into the Late Bronze Age, the prevalence of string-cut bases decreases during this period and knife cut, concentric incisions become more common (S. Salvatori, pers. comm.). An additional feature of the Late Bronze bases is a slightly more concave bottom, compared to the typically flat bases of the Namazga V period (S. Salvatori, pers. comm.). Bases can be a difficult diagnostic, however, and their forms are often less susceptible to change than rims. One example of this problem may be seen in the ‘tall-necked bottles’, characteristic of the Namazga V period in the southern Turkmen sites, but spanning the Namazga VI period as well in the Murghab (Hiebert 1994a: 44, Figure 4.6). Bases that fit this general profile were common throughout the survey area, and excavations at both Adjı Kui 1 and 9 have recovered similarly shaped bases from several contexts which support this conservatism in form (Salvatori 2002).

Despite the difficulties in identification, there is enough material evidence to support a wide-ranging occupation throughout the survey area in the Namazga V period, an assessment consistent with the finds of the AMMD survey, which identified both Middle and Late Bronze materials to the few sites recovered in the area (Cattani and Salvatori 2008). However, there are some indications of a potentially significant pattern that may be present in Area 1. Clearly identifiable Middle Bronze material is concentrated in the northern portion of the high density surface scatter, but is much less common in the region of the Egri Bogaz 4 main mound, with the exception of the single lug handle mentioned above. It is, of course, possible that the pipeline excavation contributed to an over-representation of earlier materials that would not otherwise have been exposed on the surface. However, the continuous presence of Namazga V material to the north and northwest indicates that the Middle Bronze occupation in Area 1 is fairly widespread. The lack of a comparable number of Namazga V diagnostics in the southern portion of area 1 may, of course, be partially attributable to the difficulty in assigning chronologies, and earlier ceramics may simply be obscured by the presence of later materials. However, it is worth noting that Salvatori (2008b: 62, footnote 6) has recorded ‘settlements and farms of the Middle Bronze Age’ northeast of the Egri Bogaz sites compared with the mixed Middle and Late Bronze deposits in the vicinity of the survey area. It is therefore possible that the survey data reflect a broader pattern. The implications of these distributions will be discussed more fully in Chapter 7.

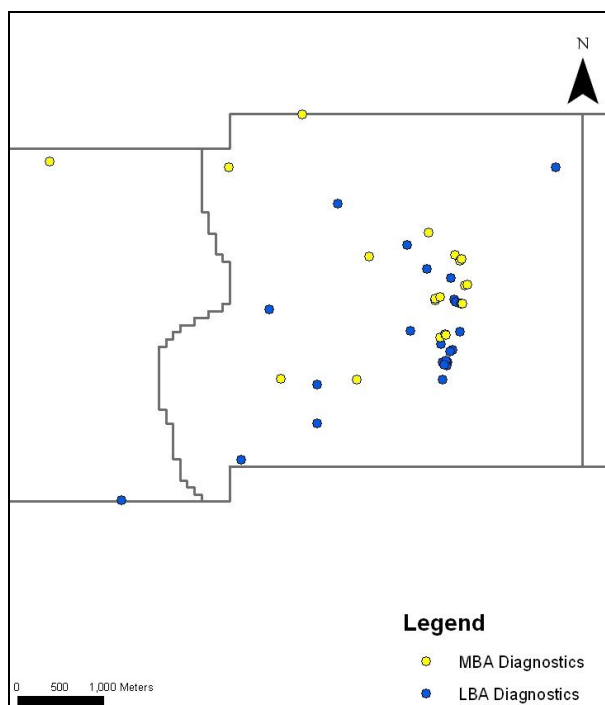


Figure 76. Distribution of MBA and LBA sherds in the Egri Bogaz 4 Region

5.9.3. Late Bronze Age (Namazga VI)

As with the Middle Bronze materials, Late Bronze ceramics were also well-represented in the survey area. Hiebert has noted that fabrics during the period tend to be darker shades of red, and fine reddish wares with a buff exterior, tentatively associated with the period, were common in the NMDS survey area. Also associated with the Late Bronze Age is the appearance of grey wares, attested by Hiebert in the south mound of Gonur, and the appearance of imported greywares has been noted by P'yankova (1993; Hiebert 1994a). At least one grey sherd contained the presence of flint inclusions, possibly indicative of an imported vessel (see discussion on petrography in section 5.10). Several grey sherds were found in the western sections of Area 1, although these were less prevalent in the high-density regions. Other grey and black wares, often coarse and handmade, occurred in eastern parts of area 2, often with evidence of blackening from cooking. Other features typical of late Namazga V and Namazga VI materials were the distinctive trumpet-shaped bases that occurred sporadically throughout the survey area. While these are well known in Gonur North, both in the necropolis as well as in domestic contexts (Udeumuradov and Rossi-Osmida 2002; Salvatori 1995), their continuation into the later phase as indicated by similar material at Togolok 1 and Gonur South complicates any attempt to ascertain a definitive date.

The appearance of both Middle and Late Bronze material throughout the survey area is interesting in light of Udeumuradov's interpretation of the region as a transitional zone between Kelleli and the later phases of Gonur (see Udeumuradov, 1989, cited in Hiebert 1994a: 40). However, it is worth noting that at least one significant Late Bronze site, Kelleli 6, has been identified in the Kelleli region (Hiebert 1994a: 17), and recent AMMD data included in the published database documents Late Bronze ceramics in association with Kelleli 3 and 4 as well. Whether these dates reflect a cursory assessment of surface material or a re-examination of excavated vessels is unclear, however, and most archaeologists maintain that both sites should be placed within the Namazga V horizon (Masimov 1979; Hiebert 1994a).

5.9.4. Final Phase of the Bronze Age and Incised Coarseware

Evidence for the last stage of the Bronze Age, sometimes referred to as the Takhirbai period and classed as the Final Bronze Age by AMMD researchers, has been noted occasionally in the recent northern Murghab transects (Cattani and Salvatori 2008), but the main locus of occupation by this period is in the southern portion of the delta, in the Takhirbai region. Indeed, with the exception of the few greywares that could fall either in the Late Bronze or Final Bronze period, and possibly some of the more coarse reddish wares, clearly identifiable forms from the period were markedly absent from the survey area. One notable exception was a flat, everted rim found in D-85, similar to Hiebert's ledge-rim bowl (Hiebert 1994a: 71, Figure 4-40). Poor representation of the period may receive indirect support in the relative lack of the incised coarsewares associated with the Andronovo cultures of the northern steppes. With the exception of a few steppe materials between Kelleli and Egri Bogaz recently published by the AMMD researchers, these materials are not common in the northern Murghab, although their presence is well documented further south in sandy areas loosely associated with Late or Final Bronze Age sites (Cattani *et al.* 2008b). In the NMDS region, only a single context (H45) yielded clearly identifiable steppe materials, about 200m away from the western extent of significant Bronze Age occupation in Area 1. While the occurrence of these coarsewares supports some degree of interaction between the steppe and the sedentary societies in the northern Murghab, it seems likely that the extent was quite limited. Elsewhere in the Murghab, the movement of Andronovo peoples has generally been seen as occurring broadly in tandem with the encroachment of desert sands, as attested by the common occurrence of incised steppe pottery on semi-stable sand dunes rather than the alluvial surfaces typical of the sedentary Bronze Age settlements. The

significance of the increased interaction between sedentary and nomadic groups, and the significance of this interplay with respect to the ultimate change in the socio-economic structure towards the middle of the second millennium, is beyond the scope of this research and has been discussed in detail elsewhere (Cattani *et al.* 2008b; c).

5.9.5. Later Periods

The Iron Age (Yaz I-III periods) was almost entirely unrepresented in the survey area. Painted wares typical of the Early Iron Age were not found except in the instance of a single sherd with painted, hatched lines in an isolated location in Area 2. The absence of any significant Iron Age occupation this far north has been well-established elsewhere (Salvatori 2008b; 1998b), and the northern extent of settlement from the period can be traced in a hypothetical east-west line approximately 10 km south of the southern limit of the survey area. North of this line, Yaz III material is extremely rare although AMMD reports have documented materials from the period in a light scatter nearly 20 km northwest of the Kelleli Oasis (AMMD GIS). Additional information about this information is not published, however, and its sheer isolation offers little substantive evidence of legitimate occupation from this period. In conjunction with the poor representation of materials from the end of the Bronze Age, it is reasonable to assume that, in accordance with the results of earlier research, the early second millennium saw a significant decrease in occupation in the northern fringe of the delta. This does not mean that no settlement existed at all, however, and further research may certainly reveal more information about the end of the Bronze Age in the region. Indeed, the interactions of incoming steppe groups with the remnants of sedentary populations in the north may look quite different from similar interactions in the more established central and southern sites, although significant research in this part of the delta has not been conducted.

With the exception of these rare Iron Age materials, the diagnostics suggest a significant gap until the middle Sasanian period, although several thick non-diagnostic sherds seen in association with these materials in the field are reminiscent of many undecorated materials found at Merv. While Sasanian materials have received significant recent study (e.g. Puschnigg 2006), those of the Parthian period are less well understood (G. Puschnigg, pers. comm.) and it is possible that some materials from the Parthian and early Sasanian period have been overlooked. Most of the sherds from the late periods are thick with a uniform yellowish-white fabric, similar to materials found in abundance in excavated contexts throughout Merv. These sherds often

occurred in sandy depressions, although field observations indicated that the sherd density for these materials was very low compared with that of the Bronze Age scatters. The absence of dense scatters from these periods, or any obvious architectural features, suggests that these materials were most likely the result of either small-scale occupations or waystations, or perhaps the result of mobile activities associated with long-distance trade.

Easier to identify were materials from the Islamic period, of which the most common were similar whitish-yellow fabrics, often with a green or black glaze on either the internal or external surface. Often, these sherds occurred singly, and several were found near the pipeline, so evidence of specific sites could not be inferred from these particular artefacts. At least one large base fragment contained a black interior glaze, which suggests a functional rather than a decorative element. Castellato (2007) notes that glazes are often used for waterproofing and support, so the identification of other glazed-interior sherds as fragments of water jars is quite plausible.

5.10. Petrographic Analysis

In order to gain a better understanding of the variations in pottery fabrics in the northern delta, a small petrographic analysis was conducted with the goal of identifying variability within the material. Ultimately, this data may then be linked with known geologies to identify variations in provenance. A successful petrographic analysis, integrated with other datasets, may reveal a wealth of information regarding the origin and production of pottery. Petrographic analysis is not unknown in the region. A major study has recently been conducted on materials from the Kopet Dag foothills in Southern Turkmenistan (Coolidge 2005), and a large, systematic analysis was recently conducted on some of the early Islamic materials in the Merv oasis (Casellato *et al.* 2007). Formal studies in the Bronze Age delta are rare, although Hiebert has cited results from Gonur. To date, the story of pottery in the Murghab through the Bronze Age and later is one of conservatism, and ware types are generally uniform, derived from local alluvial clays (Hiebert 1994a).

The first part of the analysis consisted of a pilot study of six thin sections from Area 1. Five of these, all from wheel-made vessels, were selected in order to provide a very small but representative impression of the Bronze Age materials, and the sixth was an exotic sherd consisting of a grey fabric with visible flint inclusions, which Salvatori has associated with Late

Bronze kitchenwares (S. Salvatori, pers. comm.). To this initial study were thereafter added an additional twelve thin sections (see Appendix), including five samples from the western part of the survey area. While most of the samples were selected from commonly occurring ware types in order to examine general petrographic trends, a few outliers were included as well in order to incorporate the full range of variability. In Area 1, these included a ribbed sherd from the 1st millennium AD, recovered from the surface of the Egri Bogaz 4 mound, as well as a cream-coloured sherd incised with a herringbone pattern, which Salvatori has suggested dates to the Late Bronze Age (S. Salvatori, pers. comm.).






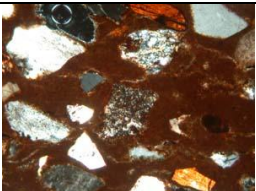

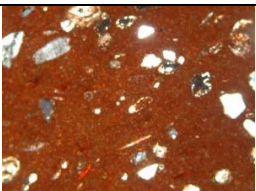

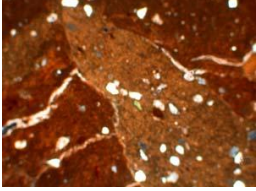
The first part of the study sought to determine whether or not broad categories could be determined that might offer a clue to different processes or provenances. Isolating individual fabric types, however, proved to be extremely difficult. While clear variations could be identified in the matrix colour, this behaviour may often be caused by various firing conditions (S. Groom, pers. comm.), and a closer examination of the mineral composition of the fabric did not reveal a clear relationship between the colour of the matrix and the petrographic composition. The matrices themselves are fine, and fairly uniform across the assemblage. Quartz is the dominant inclusion, usually comprising 10-15% of the fabric. Common to all material was a small percentage of biotite mica, typically around 1-2%, as well as plagioclase feldspars in similar quantities. Aggregates of granite were occasionally found in similar concentrations, and the volcanic origin of these inclusions may indicate that these materials formed part of the transported alluvium.

While the material could not be easily classified, there was an apparent gradient to the quartz distribution with the lowest percentages occurring in samples 2,8 and 14. Quartz distributions tend to be unimodal and poorly sorted, with grains ranging from sub-rounded to sub-angular. These characteristics suggest a fluvial rather than an aeolian derivation, although Bui (1990) has shown that grain-size signatures in transitional zones are much more difficult to interpret, and the complex fluvial-aeolian interplay in the northern Murghab epitomises such a region. Evidence of deliberate additions of temper is difficult to detect. Hiebert (1994a: 65) posits a slight increase in sand-tempered fabrics towards the Late Bronze Age at Gonur, and there is one aspect of the material that is worth addressing in this regard. Sample 15, taken from the moderate assemblage in D-70, shows very little fine quartz in the underlying matrix, but quartz inclusions are very large and angular (Table 17). A similar fabric occurs in sample 3, and it is possible that the lack of quartz in the matrix indicates a process of levigation, after which alluvial sands may have been added as temper (S. Groom, pers. comm.).

Evidence of other inclusions was limited. Several sherds exhibited evidence of linear, parallel voids, often in-filled with calcium carbonate agglomerations and possibly indicative of chaff temper. There are two outliers worth mentioning, however. Sample 12 is a grey body sherd, and contained sharply angular flint inclusions. Similar material was extremely rare in the survey area, and the sample was clearly an outlier in the petrographic spectrum. In the resource-poor northern Murghab, flint is not readily available (A. Ninfo, pers. comm.; P. Mozzi, pers. comm.). The most likely origin for flint, on the basis of accessibility, is the Kopet Dag, although Mozzi suggests that flint nodules in this region tend to be less angular than those found in the sample. Ample flint quarries may also have been available in Bactria as well as northern Iran (Coolidge 2005). Moreover, the nature of the fabric, primarily in its extremely low quartz component, appears to be quite different from the rest of the material, suggesting that the entire pot, rather than just the temper, was probably imported. Such a possibility would be in line with the increasing presence of greywares during the Late Bronze period (P'yankova 1993), and while a single sherd is too small a sample, the presence of a few similar sherds in the survey area may provide some evidence of the scope of exchange in the Late Bronze period. The only other clear outlier in the assemblage was Sample 19, taken from a coarseware sherd in Area 8. While the matrix was similar to the rest of the assemblage, large chunks of grog were clearly evident. The fabric of the grog is almost identical to the background matrix, suggesting an entirely local process of grinding and recycling local pottery as temper.

The results of the petrographic analysis primarily reveal the uniformity of the material, and suggest that little information on provenance is directly accessible using this methodology on such a local scale. Furthermore, no apparent distinction could be discerned between geographical areas, indicating that any subtle variation between clays associated with different channel system is either not discernible or requires a much more rigorous petrographic study well out of the scope of this research. At the same time, there are conclusions that can be drawn. The analysis indicates conservatism and provinciality in the procurement of clays for pottery. While there was variability in the materials studied, this was primarily related to the richness of the fabrics, rather than a substantive qualitative difference. While it is possible that the subtle variability in temper may reflect active decisions in the production process, more research is needed to determine if certain qualities may have been sought in local clays, or if production processes that involved tempering were different, perhaps incorporating naturally levigated clays (Hamer and Hamer 1975). While these possibilities are important to consider, variation may be best explained by local variation in the alluvium.

Table 17. Sample Results of Petrographic Analysis

Sample No.	Sherd Location	Sherd Photo	Thin Section (10x magnification)
8	C 64		
12	C 29		
15	D 70		
11	C 62		
19	E 32		

5.11. Additional Surface Finds and Materials

Since nearly all of the surface finds were pottery fragments, it makes sense that the NMDS survey is, in essence, a study of sherd distributions. Other finds in a survey, unlike those in excavated contexts, are often simply chance discoveries—out-of-context novelties that offer little to bolster the overall understanding of the nature of occupation. There are exceptions, of course, and small surface finds from surveys conducted at the site level have yielded information about specific occupational or productive contexts, in the Murghab as elsewhere (see section 2.6).

Metal

Nearly all of the metal finds in the survey area were recovered in Area 1. Of these, the most significant find was a recently-broken half of a stamp seal with a geometric pattern, located in the disturbed area just north of the road. In addition to this object, several small metal fragments were found in the area, including at least two on the surface of the mound just south of the road. The poor condition of these materials made it difficult to determine their function, although their comparatively long profiles may suggest that these are the remains of pins or applicators, both well known in Murghab contexts (Salvatori 2008a). While most of these materials were found near Egri Bogaz 4, additional metal fragments continued to occur nearly two kilometres to the north, as observed in a transect conducted immediately north of the survey area. Outside of the region, metal was not recovered except in the case of one striking find, a bronze axe head similar to those well documented in both the Murghab and Bactria (Figure 77). The axe was found in an isolated region on the sands in Area 8, but was not associated with any other surface finds. While the object is similar to axe-heads found in the Gonur necropolis and appears to fit clearly within the stylistic traditions of the Namazga V-VI periods (Salvatori 2008a), the find sheds little light on local settlement activity beyond the well-established fact that these kinds of materials occur in the northern as well as the central delta.



Figure 77. Copper or Bronze Axe head from M86

Stone

Evidence of worked stone, either implements or debitage, was extremely rare. Only a single instance of black chert was found during the survey. A single sub-centimetre cube of black chert, possibly debitage, was found in a test pit in Area 1 immediately below the takyr surface, in an area of unusually high ceramic density. The cultural material located in this context was extremely fragmented, and the shallowness of the deposit suggests that the material may have resulted from erosion immediately to the west. It is somewhat surprising that worked stone did not occur in larger quantities, since finished stone implements are known throughout the Murghab (Salvatori 2008a). The absence of debitage can be partially explained by the lack of stone quarries in the immediate area (P. Mozzi, pers. comm.). Stone implements elsewhere in the Murghab in Namazga V and VI periods are seen as imported finished goods, and the strongest evidence of local production from raw materials acquired elsewhere occurs in the Takhirbai period, where a local bead-making industry has been inferred from the presence of turquoise and lapis lazuli flakes on Takhirbai 1 (Vidale *et al.* 1998). The lack of finished stone products elsewhere may simply reflect the masking of primary contexts, since stone is resistant to the fragmentation properties that contribute to the redeposition of pottery. While stone tools were not recovered, larger stone materials that appear to be linked to Bronze Age occupation did occur in the survey area (see Appendix). Worth noting is a chunk of pinkish-white calcite of a type found commonly at Gonur and other Murghab sites, as well as a small chunk of yellowish onyx similar in appearance to some of the ‘mace-heads’ or ‘bishops’ staffs’ found at Togolok 21 (Sarianidi 2005: 273, Fig. 126). These materials tended to occur singly, however, and did not indicate any wider pattern of distribution.

Brick

Brick debris occurred throughout the survey area, although primarily in conjunction with the more substantial surface distributions in Areas 1 and 4. The largest concentration of such material occurred just southeast of the main Egri Bogaz 4 mound, in association with moderate ceramic densities and a few pieces of slag, and a similar scatter occurred near the northern line of test pits. Some of the debris was fired, and some signs of vitrification were reminiscent of the kiln-associated scatter on Egri Bogaz 1 as well as similar materials on Egri Bogaz 2 (see Section 5.2). These concentrations may therefore represent production areas, which may see some support in the specialised craft production areas at large sites such as Adjı Kui 1 and Gonur, as well as Altyn Depe and Ulug Depe in southern Turkmenistan (Masson 1988: 127, 150; Kohl 1984). Isolated brick fragments also occurred in Area 4 in association with moderate sherd scatters (A11), although these were too few to draw any conclusions pertaining to production or activity areas.

Terracotta

The three figurines, two of clear Namazga V type, and one that may be significantly earlier, have already been discussed. In addition to these, the only other terracotta objects recovered were two spindle whorls, one in the eastern section of Area 2 in an isolated context, and a second, similar object associated with the large scatter near L42. The occurrence of this spindle whorl with broad distribution of Namazga V and VI materials, as well as one of the Namazga V figurines, may be seen to offer some support for a significant, if localised, occupation in the western part of the survey area.

5.12. Summary

It is clear from the preceding data, even at this middle stage in the analysis, that there is an unfolding story in this distribution of 22,000 potsherds. The qualitative data, set against the restrictions of a dynamic and visually obstructed landscape, show clear signs of patterning, both of material and of possible settlement areas. Even at this point, however, it is easy to see where the old biases come into play. Perhaps the ‘tyranny of the tell’ is less problematic, with no significant mounded settlements to speak of, but it is easy to focus on the large aggregations simply because there is potentially more information there, and consequently fall into precisely the same trap the research seeks to avoid. This problem will be addressed to a significant extent

in the following chapter, which attempts to revisit the distributional pattern from fairly new and more quantitative angles.

Before this voyage into the statistical abstract, it is worth assessing the potential benefit of the survey data. There is clearly a relationship between the character of the material distribution and aspects of actual occupation, although not every scatter can offer specific information. There are also substantial indications, based on the tendency of materials to aggregate over large areas, that even though visibility may be restrictive, it is only a limiting factor in interpreting this particular archaeological landscape—not a catastrophic one. Indeed, both the geomorphology and the distribution of materials are dynamic processes that, while altering the picture of the original landscape, are able to offer substantial clues as well.

Chapter 6. Results of GIS and Spatial Analysis

6.1. Overview

The preceding chapter introduced the key observations and features of the fieldwalking survey, broadly situated against the backdrop of current geomorphology and topography. Given the extremely tenuous nature of the relationships between the surface material and the actual subsurface archaeology, it falls now to other kinds of analysis to examine how such a skewed picture can be put in perspective—and if, in fact, it is feasible to do so in such a complex landscape. The following analysis of spatial patterning aims to keep the concept of scale at the forefront of discussion, beginning with a broad overview of spatial concepts in the delta as a whole, then narrowing the analytical lens throughout the course of the chapter, ultimately focusing on particular regions within the survey area itself.

6.2. *The Big Picture: Trends from Previous Murghab Surveys*

As briefly discussed in Chapter 2, spatial analysis has played a significant role in the more recent understanding of the Murghab settlement structure (Cleuziou *et al.* 1998; Cattani *et al.* 2008a). It is useful, however, to briefly assess the NMDS findings against these observed spatial patterns. As of 2008, the prehistoric (i.e. Bronze and Iron Age) archaeological map catalogued over 900 sites,¹¹ of which 361 are classed as Middle or Late Bronze Age. Of these, only 8, including the well-known settlements of Gonur North and Adji Kui 9, are classified as strictly MBA, while 51 exhibit continuity into the LBA. New sites established during the LBA initially appear to be much more prevalent, although these may be over-represented due to the masking of earlier material. Furthermore, as addressed in Chapters 3 and 5, chronological attribution may be further exacerbated by the close similarities between the MBA and LBA plainwares throughout the delta.

Another complication, discussed in the previous chapter with specific reference to Egri Bogaz 4, is the concept of size. The estimation of site size is a complex topic in the delta, due to the tendency for material to aggregate on takyr edges or to be obstructed by dune encroachment, as

¹¹The updated inventory list as of 2008 only records 794 sites, although this appears to simply reflect that sites with higher ID numbers simply have not been processed.

well as the complex processes of erosion and deflation (also see section 7.2). For many of the larger sites in the delta, excellent topographic maps have been created using total station surveys, although these usually represent the actual mounded regions of sites, so the boundary delineations may be arbitrary and often not associated with the extent of material scatter (see maps in Bondioli and Tosi 1998: 268-297). Small, surface scatters previously identified by the Russian and Central Asian surveys are often measured by the length and width of the pottery distribution (e.g. Sarianidi 1990: 11-13), and the AMMD database indicates that size estimates of 101 of the 900 sites, including most of the named sites identified by earlier Soviet surveys, remain unmodified from their initial observations. Newly identified small scatters with no clearly discernible topographic anomalies are classified in the AMMD database as either 'spot' or 'potsherd scatter', a classification that accounts for 90 of the 361 Bronze Age sites in the delta. These are described in terms of pottery density, which is nearly always low (Bondioli and Tosi 1998: xviii), and reliable site dimensions are usually not recorded.

For larger sites, the method of identifying site size employed by AMMD researchers involved 'walking along its perimeter and marking all evident corner points along the breaking line of artefacts' primary distribution or along the edges of overlapping [geomorphological] elements...' (Bondioli and Tosi 1998: xvi). Exactly how this 'breaking line' was determined, however, is not clear. Although the complex topography of the entire Egri Bogaz 4 environment was discussed in the previous chapter, it is difficult to ascertain exactly which parameters are used in measuring dimensions. In addition to Egri Bogaz 4, the treatment of two particular sites in the database offers two very different perspectives of size estimate. One of these is AMMD 412, a Bronze Age site estimated at 6.5 ha (AMMD GIS). The site is an amalgam of Adji Kui 2,3 and 4 as originally identified by Sarianidi (see discussion in Rossi-Osmida 2007: 21). This site is conveniently located along the road to the survey area, and a chance observation revealed a large scatter of material immediately to the south which spanned more than a hectare. In the AMMD database, AMMD 412 is described as being surrounded by dunes, suggesting that the extent of the occupied area may not have been accurately measured. A different picture, however, emerges for the large post-Iron Age mounds much closer to Merv. Several of these mounds are clearly identifiable from the road and, due to their location in the southern delta, are unobstructed by sand. A cursory examination of the size discrepancy between one of these depes, AMMD 448, and its associated sherd scatter was conducted by taking GPS measurements every few metres or so around the mound. The surface material was generally confined to the mound, and similar observations were made at a second site, AMMD 36, although this was not measured. It should be noted, however, that these depes are situated in agricultural regions

which probably hindered the detection of surface material, although the actual depes can easily be discerned in the landscape. While these observations in no means represent a systematic study, they clearly illustrate the confounding impact that geomorphological conditions may have on the perception of site size, particularly in the sand-obstructed northern delta.

6.3. *General Spatial Trends in the NMDS Data*

In the NMDS study region, the results of the survey data discussed in Chapter 5 indicated the presence of at least three or four large and fairly distinct settlement regions (Figure 78). The first corresponds to the large occupied zone in Area 1. Based on the extent of the moderate to heavy scatters, this general area of sherd coverage comprises approximately 60ha, although the actual settled area is likely to be much lower. Although the limited scope of the survey could not offer an estimate of the full spatial patterning of the settlement area, the continued presence of sherd concentrations beyond the northern boundary of the survey area suggests that more limited occupation may have extended several kilometres to the north of Egri Bogaz 4. This finding is supported by the continued presence of brick and metal more than a kilometre north of the main survey region, usually associated with light to moderate sherd concentrations.

In the east-west direction, significant occupation was much more constrained, with a distinct fall-off in material concentration occurring approximately 800m to the west of the highest-density region. To the east, the decline in material was even more dramatic, with a near cessation of Bronze Age surface sherds occurring within about 300m. While this apparent eastern extent of Bronze Age material may be partially attributable to sand cover, large patches of visible alluvium and takyr surfaces in Area 1E suggest that visibility is less of an issue than an actual cessation of heavy occupation. Moreover, the presence of dense surface scatters throughout the varied landscape in Area 1 suggests that substantial occupation is unlikely to be completely obscured by such geomorphological conditions.

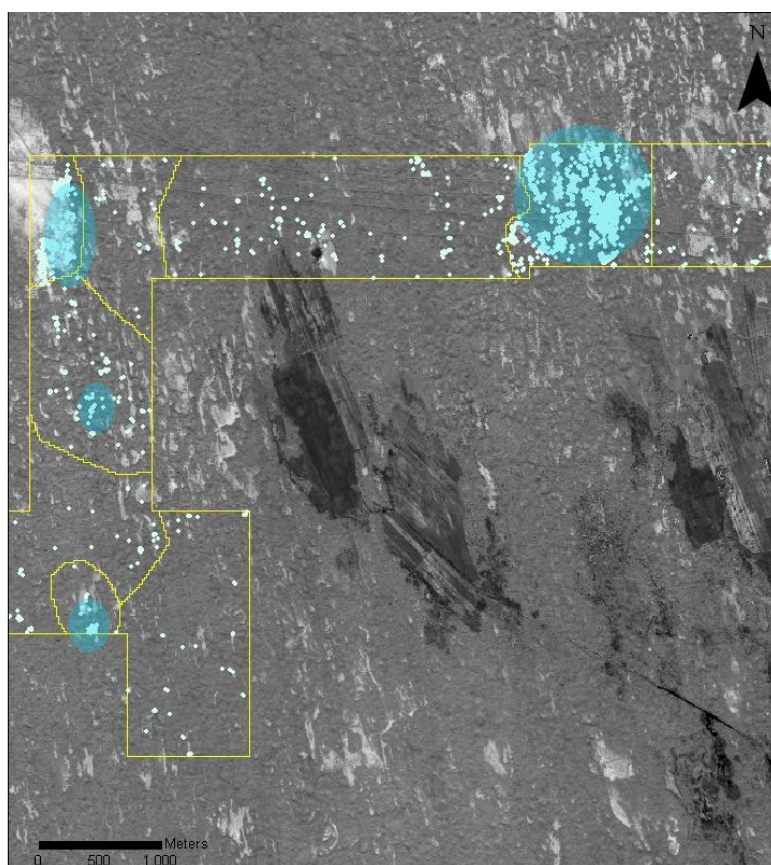


Figure 78. Major areas of Bronze Age occupation in the survey region

Beyond the immediate survey area, the relationship between this heavily populated zone and the Egri Bogaz 1-3 sites several kilometres to the southeast is unclear and it may be that these sites along with the large site designated AMMD 723 may form a distinct group (Figure 79). The nearest of these sites to the survey area, Egri Bogaz 1, is still a full 6 km away from Egri Bogaz 4 and it is not clear that these two sites are part of the same local settlement process. Additional clues, although tenuous, may be found in the remote sensing data. The apparent linearity between the Egri Bogaz sites and those to the southeast appears to be related to the orientation of modern canals, and probably represents recovery bias rather than an occupational pattern. Moreover, CORONA imagery indicates a faint north-south line passing immediately to the west of Egri Bogaz 1, possibly evidence of ancient fluvial activity, although more research is needed to understand the local hydrology. The situation with respect to Egri Bogaz 2 is even less clear, and it is not clear that these sites actually shared the same watercourses. Further research, perhaps on a more intensive scale, is necessary to determine the relationship between these sites and those further north in the survey area.

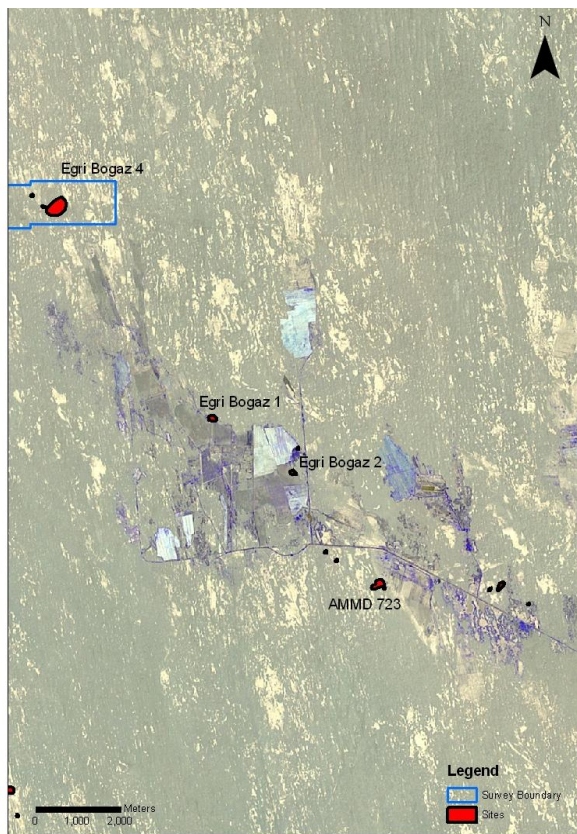


Figure 79. Egri Bogaz area in context of other previously identified sites

A second prominent region of settlement occurs approximately four km to the west of Area 1, and based on the results of the test pits appears to be largely obscured by sands on the perimeter of the large takyr in Area 4. A secondary scatter of material centred on A11 is, in turn, cut off to the west and south by dune ridges, a fall-off pattern that may be clearly seen in the sharp linear boundaries evident in the sherd density maps. The north-south orientation of material distribution exhibits a more gradual fall-off, particularly extending southward into Area 5, where a moderate increase in density, represented by small, often weathered sherds, may suggest that part of the site may have been cut off by the significant dune fields that comprise the boundary between Areas 4 and 5. The test-pits dug across this region revealed natural stratigraphy beneath the partially over-sanded surface, and it is therefore possible that this particular concentration is largely the result of erosion (see section 5.8.3). It is difficult to state with confidence the degree to which individual settlements can be extracted from this surface pattern, and the dissociation between the large material distribution on the takyr surface and the results of the test pits conducted in the same area suggests that, while the material itself is almost unquestionably associated with nearby settlement, the actual metrics of such an occupation cannot yet be assessed solely based on surface materials. Approximately 1 km south of this region, in Area 5,

there is a significant concentration of material over several hectares that may constitute a separate occupational area from those listed above. While the predominant material dates from the Bronze Age, there is also a significant quantity of later sherds from the Sasanian and Early Islamic periods. Small quantities of brick, as well as the figurine mentioned above, further suggest that this region constitutes a legitimate settlement area rather than simply a southern extension of the Area 4 occupation.

A final, and clearly distinct, occupational zone occurs yet another two kilometres to the south of the concentrations in Areas 4 and 5. While the problems of dating the brick-covered mounds in this area have been addressed (section 5.6.4), the significant scatter of Bronze Age material a few hundred metres to the south, from which nearly a dozen diagnostic sherds were recovered, is significant. The material occurs within a region of apparently complex fluvial activity that may be associated with the relative linearity of the sherd distributions extending from this region northwards towards the Area 4 sites. Without excavation, it is not possible to determine with certainty if the sand ridge immediately west of the D-63 brick concentration is associated with a canal, although the linearity of the feature, and its origin at an apparent palaeochannel to the south suggest that this may be a possibility.

6.3.1. Distributions of Material

As noted above, the majority of recorded sites are sherd scatters that occur on the edges of takyr. Table 18 shows the relationship between ceramic concentrations and open takyr surface, determined using the supervised image classification used in the visibility analysis (section 4.3.3). Two size categories of takyr, 400 m² and 1000 m², were included in the investigation, in order to examine the relationship between settlement and broader alluvial regions, and a buffer zone was set at 20m to account for the potential error in locating any one particular sherd. Small takyr regions, and depressions below the size of a single collection unit, were not included in the analysis. The results show that for each size category, observed sherd counts were significantly higher than expected sherd counts. The exception occurred when the highest density areas, 1 and 4, were removed. In these cases, sherd counts on the takyr were actually lower than expected—although this is most likely related to the preponderance of small and often oversanded takyr that may not have been detected by the analysis. When the 20m buffer zone was included, however, sherd counts in all cases were significantly greater than expected. In terms of total area, the buffer only increased the hypothetical takyr cover by a little over 1%,

although this increase yielded a striking 50-60% increase in sherds totals. This result strongly supports the findings in Chapter 4 that oversanded takyr and takyr perimeters yield the highest observable material densities. In terms of takyr size, sherds totals in the 400m² takyr zone dropped by approximately 10% when the threshold was increased to 1000m², an increase in area of about 5%. Since only about a third of the material occurs in association with the larger takyr, there is little obvious correlation between larger takyr and material concentrations. Field observations in the southern portion of the survey area confirm this observation, where long, linear takyr were generally devoid of significant material concentrations. In fact, the number of sherds associated with large takyr is heavily skewed by Area 4, which accounts for nearly 13% of all sherds in the survey area. There is, at present, no particular reason to assume that the general lack of archaeological material on broad takyr surfaces is causal, especially given the evidence to the contrary in Area 4. It is, however, worth exploring the discrepancy between the oft-stated relationship between takyr and surface material and the absence of this correlation in the northern delta. Part of the answer may lie in the realisation that broad takyr surfaces, while the remnant surface of the prehistoric alluvium, are not necessarily indicative of direct fluvial activity in the immediate vicinity (Cremaschi 1998). The test pits conducted on the takyr surface in area 4 indicated fine, sandy subsurface sediments, which may indicate continuous alluvial deposition (Lyapin 1991). While it was not possible to test a large sample of the takyr surfaces, a preliminary conclusion may be drawn suggesting that the relationship between exposed alluvium and material deposits is actually quite weak, a possibility that will be explored further in Chapter 7.

Table 18. Sherd Counts on Takyrs Surfaces

Takyrs > 400m²	Observed	Expected	Chi Sq.
All Sherds	8559	7050	403
No Buffer			(p<0.0001)
All Sherds	12196	7719	3994
20m Buffer			(p<0.0001)
Sherds excluding Areas 1 and 4	829	1150	136
No Buffer			(p<0.0001)
Sherds excluding Areas 1 and 4	1372	1196	45.53
20m Buffer			(p<0.0001)
Takyrs > 1000m²	Observed	Expected	Chi Sq.
All Sherds	7106	6697	51.73
No Buffer			(p<0.0001)
All Sherds	12190	8094	3274
20m Buffer			(p<0.0001)
Sherds excluding Areas 1 and 4	770	1025	84.7
No Buffer			(p<0.0001)
Sherds excluding Areas 1 and 4	1366	1083	172
20m Buffer			(p<0.0001)

6.4. *'Dots on a Map' Revisited—Spatial Statistics in the Survey Area*

6.4.1. Global Statistics

To this point, the spatial concepts discussed have emphasised intuitive, visual aspects of the dataset to identify patterns in the material distribution, focusing primarily on the identification of possible settled regions based on observable metrics. In the spirit of Ebert's distributional archaeology (1992), the collection methodologies identified in Chapter 3 allow the NMDS survey data to be treated as a quasi-continuous dataset. Actual continuity is, of course, purely theoretical—and even within small sample units a significant degree of uncertainty and sampling error must be acknowledged (Orton 2004; Shennan 1997). The NMDS survey area can be thought of as a full population of interlinked units from which a spatial point pattern can be extracted. For the purposes of the following analyses, two types of spatial point patterns were created. The first of these represents the total number of sherds counted in the field, with these sherds then assigned to random absolute locations within each respective collection unit. The resulting point pattern is thus only a representation of the material distribution, where any individual point represents a sherd that may in actuality be up to a maximum of 34m (the hypotenuse of a collection unit, though usually likely to be much less) from the actual sherd location barring other errors in counting or fieldwalking. A second point pattern represents the locations of positive collection units—i.e. units with at least one sherd present—and was generated using the centroid of each collection unit in the NMDS grid.

In order to assess the relevance of these spatial patterns to questions of settlement distribution, an appropriate set of questions must be devised that centre on the identification of one or more null hypotheses against which spatial patterning may be tested. In the case of the NMDS data, the initial questions deal with global aspects of the distribution and aim to assess the general character of the surface scatter throughout the survey area. Banning (2002: 51) has noted that the Poisson distribution may be used as a general model to represent a completely random distribution of sites or material in the field (Complete Spatial Randomness or CSR), although the use of the Poisson model as a spatial null hypothesis has been criticised by Nance and Ball (1989: 40) in environments where clustering is known to be present. These problems with the distribution are exacerbated even further when recovery biases are factored in, and assumptions of randomness in the underlying spatial pattern may become increasingly unreliable.

Nevertheless, as Banning (2002: 51) has noted, the Poisson distribution is still useful to assess the general character of point patterns, before delving into secondary or more local factors that may be affecting the distribution.

The following analysis steps through a suite of methods for considering point patterns, with some ultimately proving more useful than others. The first approach addresses the extent of clustering in the survey area, and begins with the simplest and most conventional test, using a Clark-Evans nearest neighbour statistic (Clark and Evans 1957). This test measures the mean distance between any two points in order to assess the overall degree of clustering with respect to a Gaussian distribution. While still commonly employed, the statistic falls short in that it only considers one analytical scale. Moreover, the metric offers only a global assessment of the degree of clustering, while saying nothing of local or regional patterns. Thus, in a convoluted and only partially visible landscape like the Murghab, such a statistic can only be used as a starting point.

Table 19 presents the Clark-Evans statistics for the entire survey area, and offers confirmation that complete spatial randomness (CSR) can be rejected over the survey area. The similarity in the ratio of observed to expected distances is similar for pockets of 5 or 10 sherds, suggesting that similar processes may be at work for small clusters, whereas the much higher ratio for all positive collection units (sherd counts of 1 or more) indicates that sporadic occurrences of a single artefact may have a significant impact on the overall pattern of clustering.

Table 19. Degree of Clustering (Clark-Evans Nearest Neighbour Test)

Full Survey Area (sherd counts)	Avg/Expected Nearest Neighbour (m)	Z	Significance (p)	NN Ratio
>=1	30.2/58.9	-44	<0.01	0.51
>=2	34.5/76.6	-38	<0.01	0.45
>=5	38/106	-31	<0.01	0.35
>=10	48.5/	-24	<0.01	0.36

6.4.2. Multiscalar investigations

While the Clark-Evans test can be useful in providing an overall degree of clustering, it faces an inherent drawback in that it only evaluates the distance to the nearest neighbour of a given point,

offering only a single scale of analysis. While such a metric can help determine the global degree of clustering at this scale, it provides no information on spatial behaviour at larger scales, so broader clustering patterns may be overlooked (Mehrer 2006: 179). In order to examine several scales simultaneously, another global statistical method known as a K function has been developed (Ripley 1977). The K function offers a way around the scale problem by measuring the degree of clustering over a range of distances. The approach has not often been applied to archaeology (for an example see Bevan and Conolly 2006), but offers the possibility of looking more closely at spatial patterns of archaeological landscapes that may not be visually apparent.

In order to apply the K function to the survey area, two point patterns were generated. The first contained all sherds, where each point corresponded to a hypothetical sherd placed randomly within its corresponding collection unit. The second included just the centroids of collection units where a minimum of 1, 5 or 10 sherds was present—although the latter number was only prevalent in Area 1. The analysis was run over a total distance of 500m, representing the maximum distance recommended by Ripley based on window size and sherd density (A. Baddeley, pers. comm.). The significance envelope ($p < 0.01$) was established using a Monte Carlo simulation of 99 iterations. Figure 80 indicates that there is very clear, heterogeneous clustering both across the overall survey area and in Area 1. The appearance of clustering at all levels is a general indicator of spatial heterogeneity over the entire range of distances and, without further treatment, restricts more elaborate uses of the K function for interpretation. Bevan and Connolly (2006) observe that such patterns of heterogeneous clustering are often indicative of different processes operating at different spatial scales that may not be identifiable without more targeted investigation of more homogeneous analytical regions.

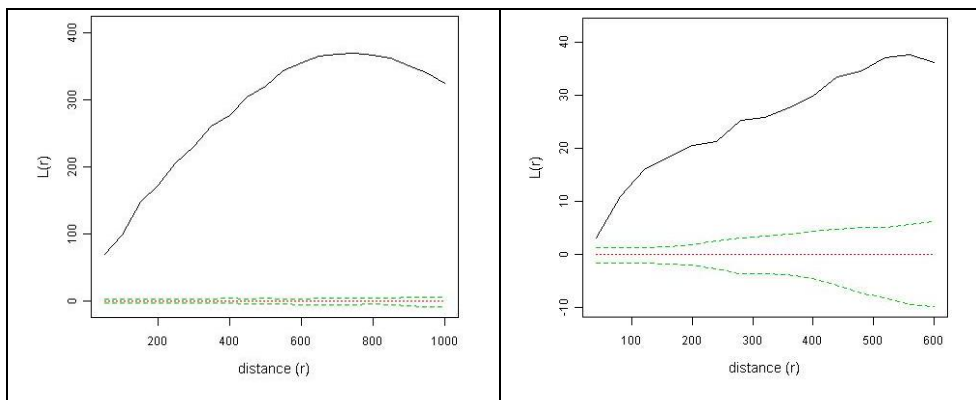


Figure 80: Comparative multiscale analysis for Area 1 and full survey region. *Left:* Full survey area. *Right:* Area 1. The figure shows the L-function, a scaled version of the K function (Wiegand 2006). The significance envelope is defined by the lines on either side of $L(r)=0$.

When the dominant Area 1 is removed from the analysis, the other regions exhibit a general uniformity in their patterns of aggregation, although there is clear variability between regions (Figure 81). The typical behaviour exhibits clustering at low to medium distances for positive collection units, returning to complete spatial randomness beyond about 350m. This radius corresponds to a region of about 12 hectares, suggesting that the processes driving these clustering patterns are substantial in terms of geographic area. Interestingly, this spatial behaviour is most striking in regions 2,6 and 8, corresponding to low-density regions of the survey area. Somewhat unexpectedly, Area 4 shows a stronger similarity with these regions rather than Area 1. Rather than the spatial heterogeneity that characterises the heavily settled region, Area 4 shows a rapid drop to CSR at 300m. Actually, the explanation in this case is fairly straightforward, as the observed behaviour is consistent with the approximate diameter of the sherd aggregations in Area 4, beyond which the distribution decreases dramatically.

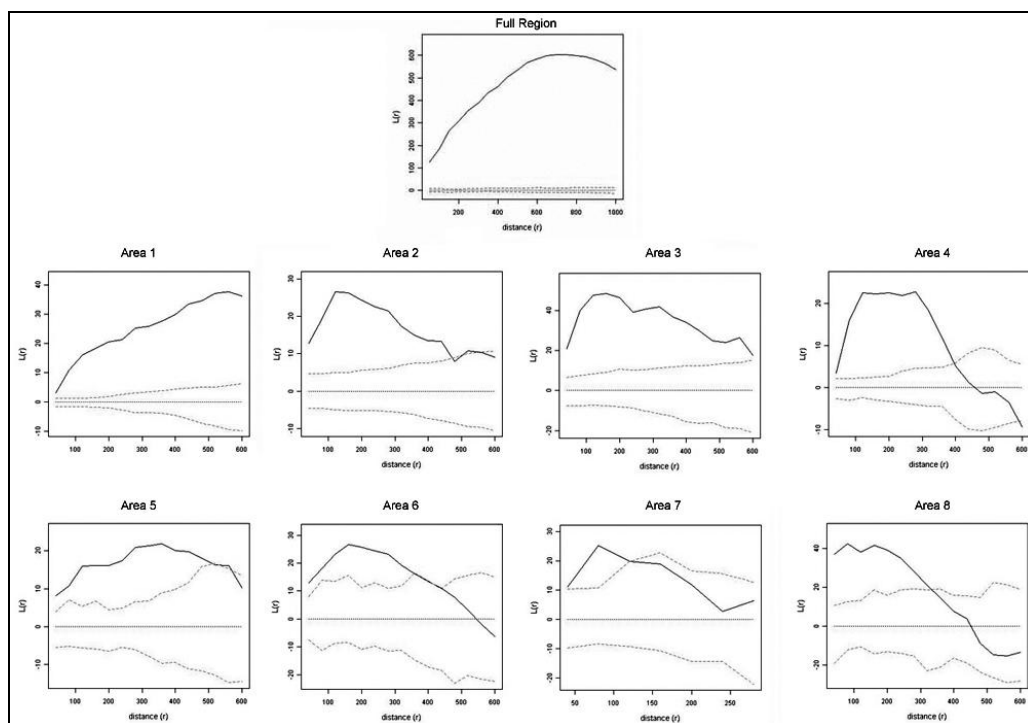


Figure 81. Ripley's K function (unweighted) for full NMDS survey area and individual analytical units.

Apart from Areas 1 and 4, it is difficult at first glance to reconcile the visual character of the sherd clusters in these other areas, which often occur in small clusters in depressions, with the fairly large aggregation radius indicated by the k-function. One clue, however, may be seen in the K function in Area 8. This region indicates that, for positive collection units (sherd counts of

one or more), the radius beyond which clustering yields to complete spatial randomness (CSR) decreases from 400m to 100m. This suggests, as also indicated by the Clark-Evans test, that the occurrence of isolated sherds contributes heavily to the clustered patterning at large scales. This effect is reasonable, given that the sherd count of each positive square is not taken into account, but it calls into question the reliability of the K function as a method of interpreting the configuration of material in cases where multiple processes are at work.

The results of the above analysis suggest that the aggregational character of the material in the NMDS survey area exhibits different forms, although unfortunately provides very little additional information. The spatially heterogeneous clustering in Area 1, indicative of a complex and multifaceted distribution, does seem to be restricted to that particular region and is not characteristic of smaller-scale settled areas which present more discrete spatial boundaries as indicated by more rapid returns to CSR. Off-site areas—pertaining in this case to regions of limited sherd densities, although small sites may have existed in these areas—tend to show more gradual slopes, although the distances in question are fairly similar, with returns to CSR occurring between 300 and 400m. One implication of this pattern is that even moderately dense areas such as those in Areas 4 and 5 have fairly well-contained distributions with respect to the surrounding landscape.

In order to employ the K function to examine more localised behaviours in the distribution, a variant (Figure 82) may be used known as the local K function (Getis 1984). This method measures the proportion of point-pairs within a certain radius of a given point I, and tests for CSR by comparing this proportion with that obtained through random point distributions (Walker *et al.* 2007). This localised variant can be used in conjunction with the global K function to assess clusters and/or dispersed areas that may be contributing to the point process. One advantage of this method is the systematic way in which it may be used to suggest meaningful sub-regional units of analysis, ultimately offering a more statistically sound means to divide up the continuous survey data given the fact that the distribution is clearly neither random nor produced by a single process. In the interest of maintaining a manageable dataset, the function was run only on positive collection units, operating over a range of distances from 50m (corresponding to the minimum distance for the k-function) up to 500m. At short distances, from 50 to 150m, aggregations are common throughout the survey area, generally declining in number beyond about 200m. At higher distances (beyond $d=200m$), most of the localised clusters no longer play a larger statistical role, and these broader regions are restricted to the huge scatters in Areas 1 and 4, Area 7, and a broadly distributed group of sherds just north of the

field system in Area 2. This latter region persists at greater distances (>300m) although the presence of several sherds from the Sasanian and Islamic periods, as well as the somewhat weak statistical signature suggest that different phenomena—likely natural processes in addition to small-scale and perhaps non-cohesive localised settlements—may be contributing to this particular pattern. Unfortunately, the presence of heavy agriculture to the south rendered a further exploration of this particular region infeasible, although scattered surface materials may indicate a continuation of this pattern to the south.

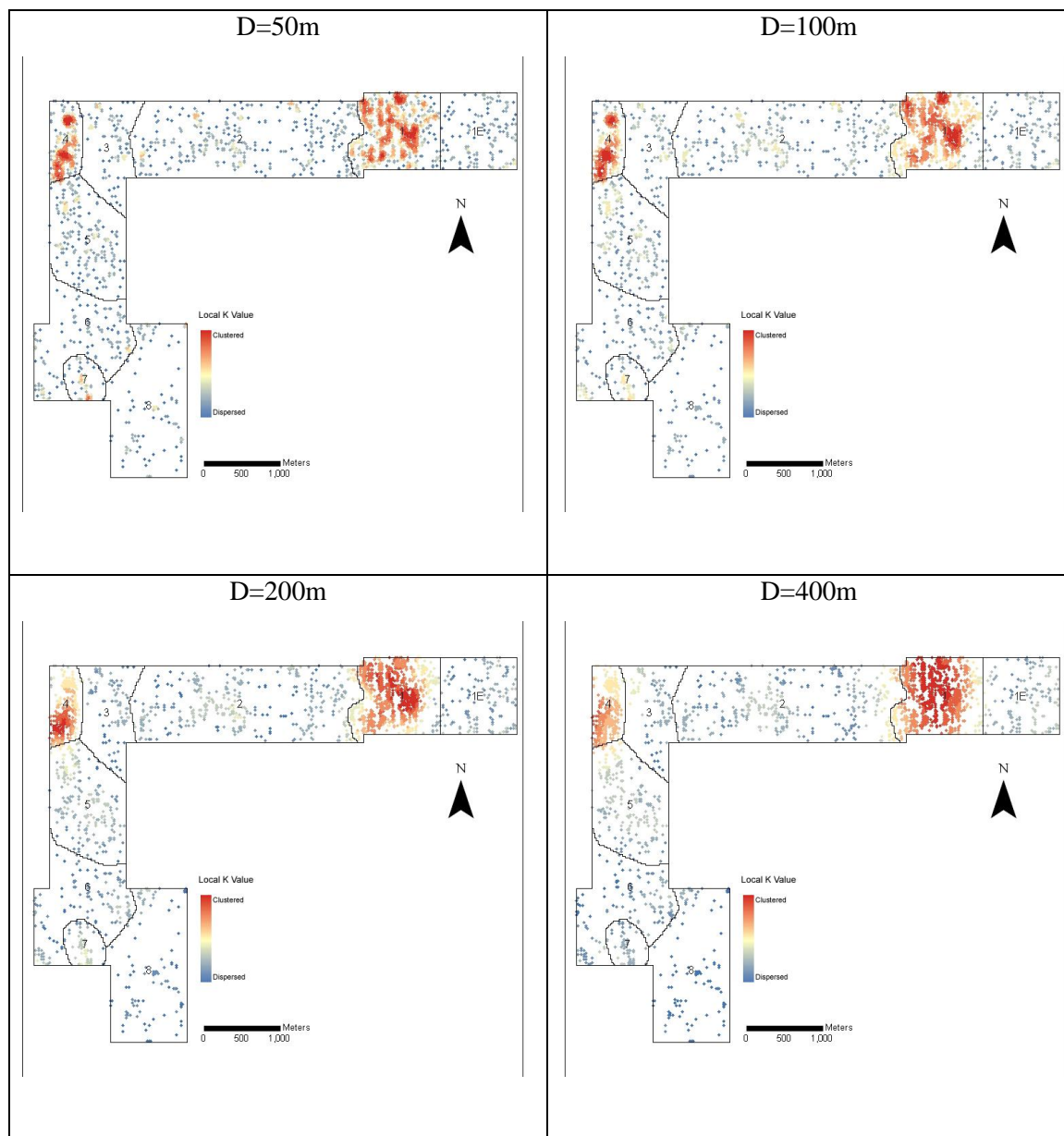


Figure 82. Local K function for NMDS survey area. Red dots indicate clustering at the given distances, while blue dots indicate dispersal.

6.4.3. Local Indicators of Spatial Analysis (Getis-Ord and Local Moran's)

The local Ripley's K represents an initial foray into local and regional processes that cannot be detected at the global level, and, as indicated, suggests that the spatial distribution throughout the survey area is highly varied. In order to explore these local patterns more fully, a host of other methods are available under the category of Local Indicators of Spatial Analysis (LISA) (Anselin 1995). Two of these, the Getis Ord G_i^* statistic and the Local Morans statistic, address patterns of spatial autocorrelation—the tendency for similar values (in this case counts of sherds per square) to occur in close proximity to each other. While not yet heavily used in archaeology, a few applications, particularly with respect to Mayan settlement patterns have shown such spatial statistics to be useful (Premo 2004).

Getis-Ord G_i^ Statistic*

The G_i^* statistic is a local variation of the Getis Ord General G statistic, a global measure of the aggregation of high values—in this case sherd counts—in a spatial point pattern (Getis and Ord 1992). The advantage of the G_i^* statistic is that it provides a value for each point within the analysis, facilitating a visual and statistical representation of areas of higher concentration. For this study, the original sherd counts were modified by taking the square root of the total for each collection unit, in order to retain the zero values for empty collection units. The G_i^* analysis was applied to the full survey area, then to each individual analytical unit. Following Premo (2004), a multi-scalar approach to the G_i^* statistic was employed, where distances from 50m to 200m were evaluated. The 50m threshold was selected as a minimum distance in order to account for the inherent error in sherd location as well as possible larger errors in fieldwalking itself.

Figure 83 shows the results of the G_i^* analysis over the entire survey region at 100m and 200m. Immediately apparent is the degree to which the increasing analytical scale (distance) affects the perception of the settlement pattern. At $d=200m$, only two regions show substantial 'hotspots' of highly autocorrelated sherd counts. For the purpose of this discussion, these areas may be considered statistical 'regions of influence' and comprise 40.5 ha for the western 'hotspot' and 108.6ha for the eastern one. While these figures provide a useful representation of the statistical range of material distributions in the landscape, the numbers clearly cannot be taken at face

value. One reason is that the limit of this influence in Area 1 clearly extends beyond the main survey area, whereas the Area 4 ‘hotspot’ is clearly bounded. Moreover, it is difficult to independently assess the character of these autocorrelated regions. There are hints of patterns, such as the double-ring appearance of the western ‘hotspot’. However, there is no way of differentiating the character of material within a statistically significant region without additional knowledge.

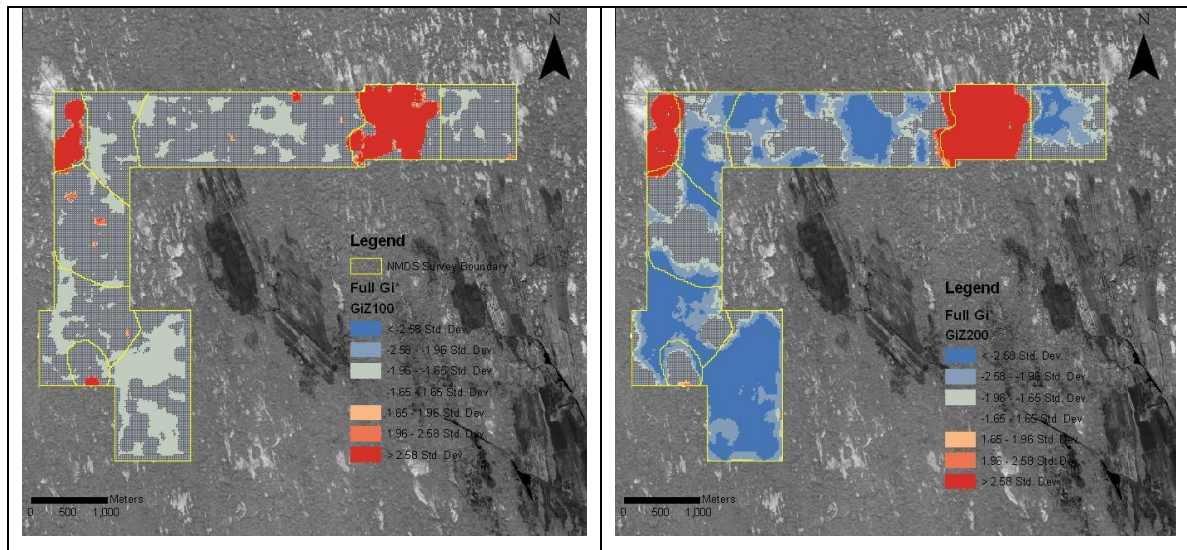


Figure 83: Autocorrelation over the NDMS Survey Region using the G_i^* statistic. *Left:* Threshold distance = 100m. *Right:* Threshold distance = 200m. Red areas represent significantly autocorrelated high values, and blue areas indicate significantly autocorrelated low values ($p < 0.05$).

When the analytical scale is narrowed to 100m, the complexity of the distribution becomes much more apparent although this distance is still too large to identify complex patterning at the local level. In Area 1, the southern extent of the distribution becomes more complex, revealing two tails of statistically significant clustering. The absence of diagnostic material between these two tails suggests that the G_i^* analysis has identified a legitimate phenomenon, which may be explained by the presence of a possible palaeochannel, the significance of which will be discussed more fully in Chapter 7. This result also indicates that the southern extent of occupation most likely continues to the south of the survey area, although an additional east-west transect just south of the region, yielded generally low-density material. The high densities directly associated with the Egri Bogaz 4 complex most likely did not continue this far south, although the material scatters may be reflective of small-scale, outlying occupation.

While statistical analyses of the entire study area offer insight into the relative size of spatially autocorrelated regions, they too are distorted by the overwhelming preponderance of material in a few concentrated areas. As a result, it is difficult to see variation in low-density areas, the ‘background scatter’ discussed by Bintliff and Snodgrass (1988) (see sections 5.6.3, 7.4). In order to gain perspective into these regions, Areas 1 and 4 were removed from the subsequent analysis (Figure 84), making it easier to identify more subtle departure from CSR that otherwise may have remained undetected.

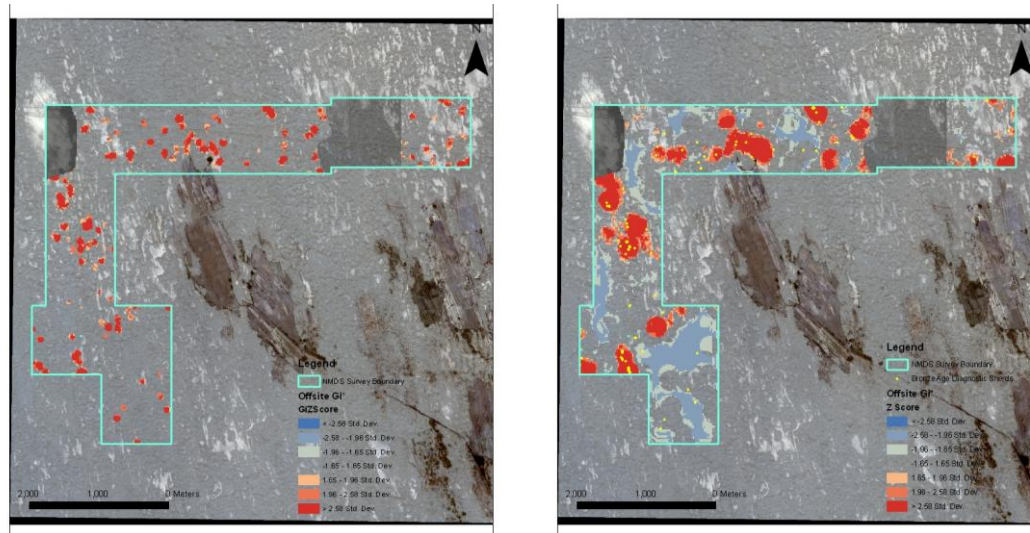


Figure 84. Gi* surface for ‘offsite’ regions (excluding Areas 1 and 4) *Left:* Distance threshold of 50m. *Right:* Distance threshold of 150m.

Immediately apparent is the extent to which the removal of the highest-density concentrations reveals substantial variability in the material distribution, which may otherwise be undetectable. Beyond the main occupational areas, the Gi* analysis offers statistical evidence of offsite clustering that suggests a highly variable spatial distribution, but one that tends to occur in substantial aggregations that may measure 150-200m in diameter. An assessment of how these aggregations may relate to actual settlement, however, is difficult and requires the integration of non-statistical, qualitative aspects of the data. Some information may be gleaned by examining the distribution of Bronze Age diagnostic material against the statistically significant clusters (Figure 85). While there appears to be some correlation between diagnostic material and spatially autocorrelated regions, the relationship is not always clear. In the northern part of the survey area, for example, diagnostics often occur in statistically neutral regions, and the appearance of several isolated diagnostics in ‘cold spots’ in the southern part of the survey area (Area 8) is likely attributable to the sporadic occurrence of isolated sherds rather than any

traceable archaeological or post-depositional pattern. A different pattern occurs in Area 5, where a 500m line of Bronze Age diagnostics occurs in the western part of a statistically significant cluster. The slight disconnect between the diagnostics and the autocorrelated sherd densities suggests that the statistical results are detecting small to medium-scale dispersals of material that transcend the boundaries of core occupational areas, which follow a linear orientation likely related to their orientation along a channel system (see below and section 7.7). It is quite reasonable to expect that erosion has played a significant role here as well, resulting in the redeposition of small sherds into lower lying areas.

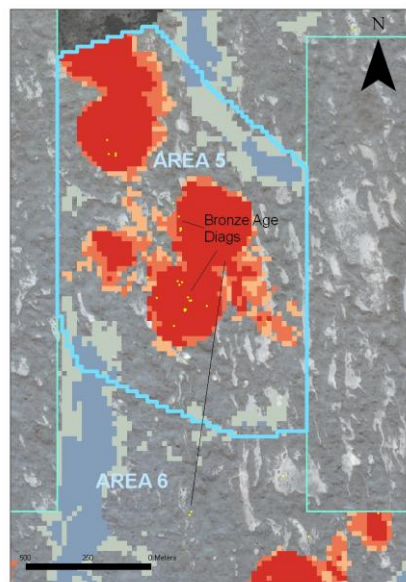


Figure 85. Relationship between diagnostics and ‘hotspots’ for Area 5. Regions of statistical significance are determined by the Gi* statistic at a distance threshold of 150m.

Local Moran’s I Statistic

While the Gi* statistic was useful in providing a statistical measure of the ‘clumpedness’ of the surface distribution, it was less effective in identifying statistical change within these zones. To probe more deeply into these behaviours, another LISA function, the Anselin Local Moran’s I, can be used. Essentially a localised version of the Morans I measure of global autocorrelation, the function may be used as an alternative method of statistically identifying clusters (Anselin 1995). The Local Morans I offers an advantage in its ability to identify outliers, anomalous regions of poor autocorrelation with the surrounding area.

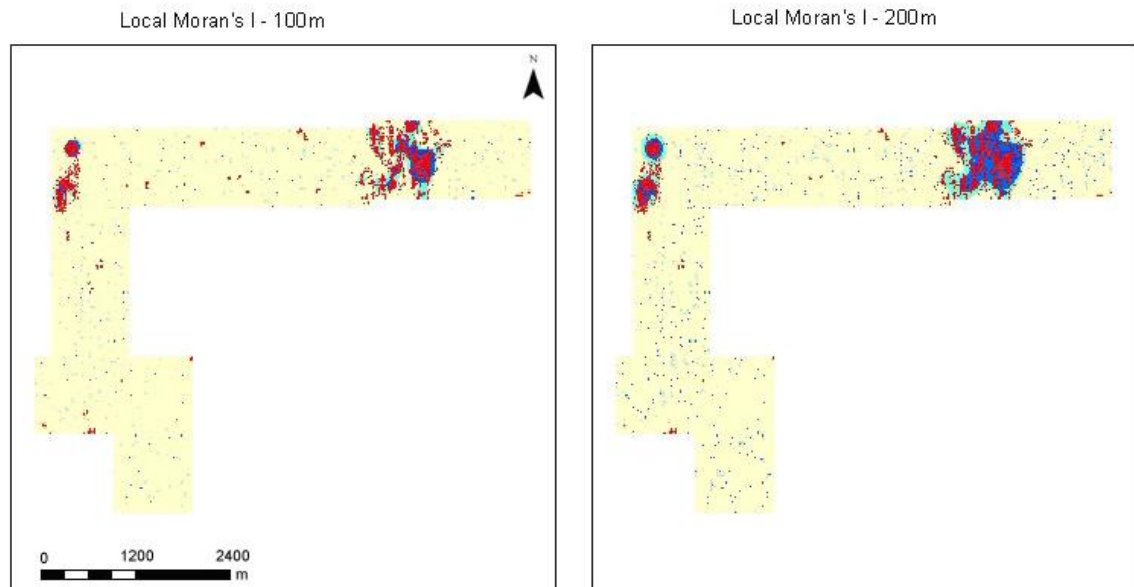


Figure 86. Autocorrelation over the NDMS Survey Region: Local Moran's I statistic

As with the G_i^* tests, the Moran's I was evaluated at distances from 50m to 200m (Figure 86). While highly autocorrelated regions are similar in the two tests, the statistical landscape provided by the Moran's I rendering is different in informative ways from the G_i^* statistic. The large clusters in Areas 1 and 4 offer some insight into the complexity of the boundaries of these distributions that cannot be detected using the G_i^* statistic. In both areas, statistical boundaries are evident in the dark blue 'halos' that can be seen surrounding the primary distributions. In the Moran's I rendering, these rings represent regions of low spatial autocorrelation at a significance level of $p < 0.01$ indicating that the sherd totals exhibit a significant departure from the surrounding distribution. In terms of raw sherd counts, these halos represent areas of extremely low or zero density. The structure of these statistical haloes is interesting, in that, with the exception of the western portion of Area 1, they do not adhere to a linear pattern as may be expected if the only contributing factor were the restricted visibility caused by dune ridges. This suggests that actual fall-off, rather than visual obstruction, is primarily accountable for the radial patterning. In Area 4, there appear to be several localised post-depositional behaviours at work. In the north, the region of high significance is confined, presumably representing a large but relatively restricted area of large, loose sherds on the takyr surface. The lack of subsurface material associated with this scatter, although cultural remains were found beneath the dunes 100m to the east (see section 5.6), may be indicative of a localised erosional process, possibly a deflation event and subsequent redeposition of material a short distance from the actual occupation area. The southern area, by contrast, is much more extensive and the fall-off in sherd

totals markedly more gradual. As noted in Chapter 5, diagnostics in this region were small and heavily abraded, and the land cover comprised primarily eroded takyr surfaces. The confluence of these factors suggests that, in the south, the lack of significant dune protection may have left the region open to more serious deflation, resulting in a larger dispersal of heavily abraded materials.

As with the G_i^* statistic, the Local Moran's analysis shows the degree to which broader analytical scales affect the statistical interpretation of highly autocorrelated areas. At the 50 and 100m levels, the Moran's I analysis identified 22 and 26 clusters respectively, with the large scatters in Areas 1 and 4 identified as individual entities. A dramatic shift occurs at $d=200m$, at which only 14 scatters could be statistically identified, several of which comprise only two or three collection units. At this largest scale only a few scatters, H-19, L-62, L-26 and D-70 have significant distributions greater than two or three collection units. For these four regions, the area of greatest statistical significance ranges between 100m and 150m across, or approximately 1-2.5 ha. While such a metric must be interpreted with caution in attempting to derive the actual dimensions not only of actual settlement areas but the current dimensions of the scatters, it does offer a route to the interpretation of the potential influence that a site may have had on the landscape.

Implications of Local Statistical Methods in Interpreting the NMDS Data

The preceding analyses suggest that, by applying these distinct yet related statistical analyses to the NMDS survey data, a series of unifying themes can be drawn. Perhaps the clearest implication is that the spatially heterogeneous distribution of surface sherds is extremely complex, and that settlement cannot—and should not—be inferred from statistical processes alone. Indeed, autocorrelated sherd densities may reflect processes of post-depositional fragmentation or deflation rather than actual areas of settlement or other activity, and these possibilities will be explored more fully in Chapter 7. However, there are some general archaeological implications worth addressing more fully. All three analyses of local patterning easily discerned the high density regions in Area 1 and Area 4, but indicated significant spatial heterogeneity within the distributions, offering statistical evidence that the discrete concept of 'site' is overly simplistic and that complex local processes were at work (see discussion in section 7.4). In other, lower-density regions, the data indicate spatial heterogeneity as well. In these regions, statistically significant aggregations are typically restricted to 2 or 3 ha. These

dimensions have clearly been inflated by post-depositional processes, although actual settlement is suggested by the presence of diagnostics in the vicinity of the largest concentrations. With respect to the 'background scatter' itself, the Gi* analysis suggests that there is some relationship between regions of heavy dune cover and significant negative autocorrelation. Conversely, broad regions of high clustering tend to align loosely with the large takyr systems in the survey area or in moderately over-sanded regions north of cultivated takyr zones. Although such observations can only be general, they offer statistical support for the association of broad material scatters with fluvial systems. Interfluvial zones, by contrast, exhibit low density, loosely autocorrelated surface scatters that may occasionally deviate from CSR at broad scales.

The results of these spatial investigations suggest that, beyond the main occupational zones, there is a range of about 200-300m beyond which aggregation ceases to become statistically significant. While clustering is often detectable at shorter ranges, localised settlement and post-depositional processes affecting the material scatter may simply operate at too fine a scale to be adequately investigated by the statistical methods. At the other extreme, beyond about 300m, the effects of these processes fall below the detection thresholds. Clearly, this statistical phenomenon does not indicate that such processes actually cease to have any influence beyond the clusters, but it does offer the opportunity to propose theoretical limits for offsite behaviour. However, these may vary according to region. In Area 5, for example, clustering occurs through around 500m, although a look at the graphs for this area indicates that the spatial patterning is less straightforward than initially apparent (Figure 87). High-density collection units show two peaks, at both 200m and 400m. These findings may indicate aggregations of small communities, perhaps loosely organised within larger units, and such possible modularity will be discussed in section 7.6. Ultimately, however, while some archaeological insights are possible, and while the above investigations clearly demonstrate the presence of different processes operating at multiple scales, the role of these methods in explaining specific archaeological or post-depositional processes is very limited.

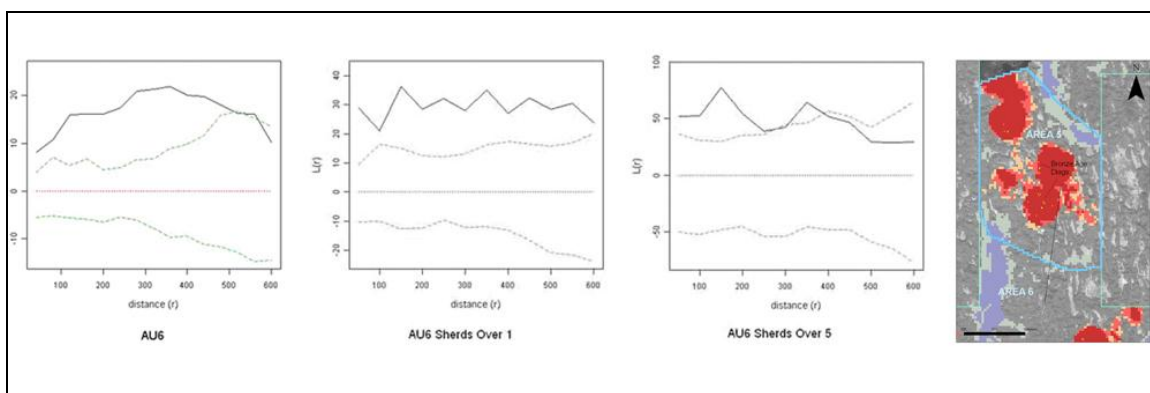


Figure 87. Comparison of Ripley's K and Getis Gi* for Area 5

6.5. *Directionality in the Murghab Landscape*

6.5.1. Visual Anisotropy

To this point, the emphasis of the analysis has been on spatial heterogeneity and scale, the results of which have primarily offered confirmation of expected trends in such a varied landscape. Absent from these methods, however, is a means to investigate the apparent directional or anisotropic characteristics (here used interchangeably) both of the material distribution and of the geomorphology of the region. Even a visual assessment of the survey area clearly shows that linearity is prominent a) in the distribution of known sites throughout the delta; b) in the distribution of individual artefacts and c) in the underlying fluvial and dune morphology. Although the linear orientation of settlement in the Murghab has not been researched in significant detail, such an alignment of occupation is not surprising, given the need to access water in a marginal environment. Even the early Murghab surveys indicate clear linear orientations in the Gonur, Taip and Auchin regions, seen by Masson (1981) as evidence for a broad, well-developed irrigation system, although this conclusion has been questioned by Bader (1996) who sees the scale of Bronze Age irrigation as relatively limited compared to later periods. Certainly, settlement chains are a common feature of arid-zone agricultural settlements that require irrigation. Adams' 'ribbons' of tells in the lower Euphrates (1981: 21) offer some of the best known evidence for such patterning, and these implications will be treated in more detail in the following chapter.

While much of this patterning seems to be at least partially reflective of settlement orientation, linearity presents itself in additional ways that may also be influenced by recovery methodology. In the northern delta, for example, the apparent WNW-ESE alignment of known sites, beginning

in the Kelleli region and extending through the Egri Bogaz group towards AMMD 723, is almost undoubtedly influenced by the greater accessibility in this region facilitated by roads, although several of the sites in the area were discovered as a result of the transect conducted by Salvatori in 1996 (Cattani and Salvatori 2008). Moreover, even the sites that appear to be oriented along ancient fluvial networks are not immune to the kind of accessibility bias just mentioned. Since the earlier surveys were largely conducted by vehicle, it stands to reason that increased access along modern irrigation canals would have increased recovery potential along those tracks, and some relationship can be seen between archaeological sites and modern canals. Such patterns have never been systematically analysed for the Bronze Age, although Cattani and Salvatori have suggested that in Yaz III period communities in the Lower Murghab, the alignment of subtle altimetric variations indicates the presence of dwelling units on opposite sides of a palaeochannel (Figure 88). Unfortunately, the lack of such fine scale topographic information, confounded by the complexity of the northern Murghab landscape, rendered a similar investigation unfeasible during the current research.

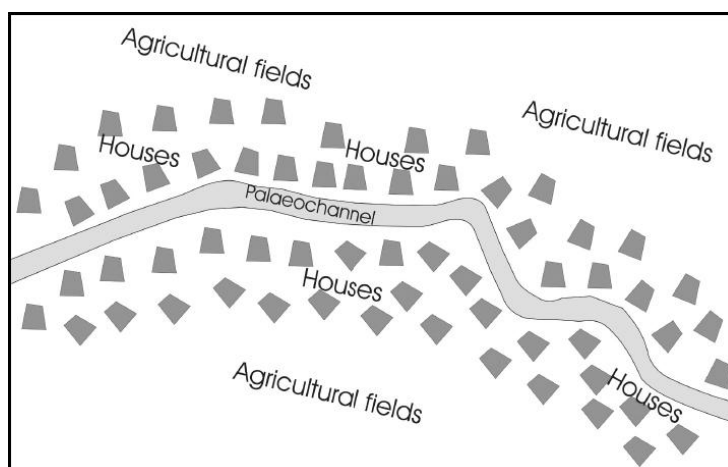


Figure 88. 'Synthetic model of Yaz III farm houses pattern along a river branch.' (Cattani and Salvatori 2008: 13, Figure 1.7). (reprinted with permission)

The detection of anisotropy in the settlement landscape need not only apply to settlements themselves, and the finer scale of the NMDS survey offers a glimpse of directional effects in material as well. Such effects are themselves non-stationary, as anisotropic spatial processes are by definition not uniform. As such, they may contribute at least partially to the interpretative difficulties associated with the multi-scalar and autocorrelation analyses described in the previous section. Perhaps the most prominent example of anisotropic effects can be seen in the western portion of Area 1, where at least three clearly defined north-south bands of alternating high and low densities are easily discernible (Figure 89). Elsewhere however, where the

delineation between high and low densities is less apparent due to the lower density of material, the effects of an anisotropic landscape are difficult to identify visually. Two linear features within the spatial pattern do stand out, however. The first extends south through Areas 4 and 5 and is apparently attributable to a significant dune ridge as evidenced by the clear cessation of material in the eastern portion of Area 4. An additional north-south feature is faintly discernible in the eastern part of Area 2, although the relatively low densities of materials in this region render the linearity less pronounced. Before examining the directional aspect of the spatial distribution in detail, however, it is useful to first discuss some basic factors that may play a role.

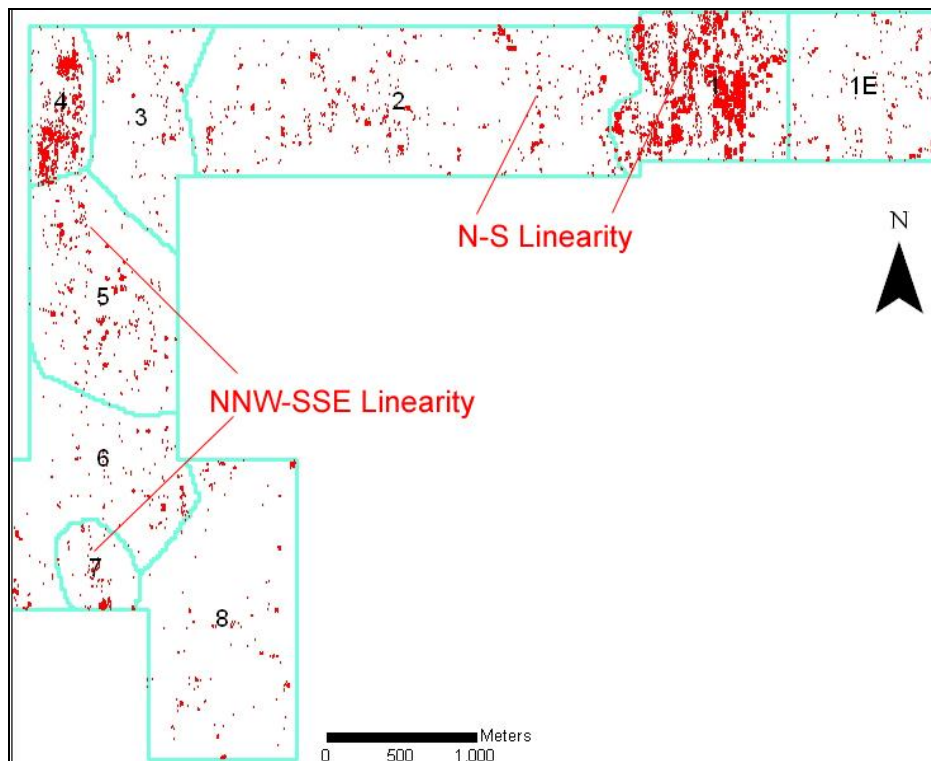


Figure 89. Visible Anisotropy in the NMDS Sherd Distribution

In the northern Murghab landscape, there are two predominant geomorphological features that exhibit strong anisotropic signatures, and the orientation of each is clearly visible in the satellite imagery. The first is the dune topography, addressed in Chapter 4. The second feature is the palaeodelta itself, which, while not directly inferable from the takyr alignment, tends to be orientated slightly more towards the NNW, although not all channels necessarily follow this orientation. A third potential anisotropic influence is inherent in the survey methodology, and the north-south fieldwalking orientation may have a directional influence on the recovered material. One issue here is that different walkers may perceive surface material differently (Van Leusen 2002: 4.6.3). Whether this is a result of vision, or the tendency of one walker to

methodically scan the ground directly in front versus another's proclivity to scan the entire transect area, it is very unlikely that two walkers would report the same sherds in the same transect, and linear discrepancies may thus arise between transects. This problem is potentially exacerbated in higher density areas, where sherd totals higher than a few dozen tend to fall to widely variable estimates rather than actual numbers.

Table 20. Observed Sherd Totals by Walker Line (counts from western half of Grid Square C)

Line	Sherds>=1	Sherds>=5	Sherds>=10
10	313	77	39
30	316	65	36
50	218	36	22
70	203	43	26
90	285	51	24
Chi Sq.	42.4	20.3	7.8
p value	<0.00001	0.0004	0.09

In order to test whether each walker's recovery potential could be a factor, a chi-squared test on sherd counts from the western portion of Grid C was used (Table 20). While close enough to high-density areas to provide an effective sample size, this area offered a potentially more statistically-disposed distribution than in the zones of extremely high and varied density just to the east. Because of the potential for vast differences in each walker's estimate of sherd counts, however, the test uses the number of positive collection units recorded rather than raw sherd counts. The high chi-squared values suggest that random chance does not sufficiently account for the discrepancy among walkers, and the next step is to look for factors that may influence recovery. Immediately evident are particularly low counts at lines 50 and 70. Line 50 represents the author's own transect, and it is probable that in-field multitasking (e.g. notes, photography, etc.), while necessary, contributed to reduced totals, although the significance of that reduction decreased with higher sherd totals. When sherd counts are high, however, the disparity between walkers was no longer statistically significant. In addition to discrepancies between walkers, there were potential errors in fieldwalking, where a general shift of 10m to the left or right could affect the entire line. Such an occurrence could result in either an under-counting of material along certain transects, or repeated counts in other lines. This effect, however, was mitigated by the resetting of each line after 100m, and GPS track logs maintained for much of the survey indicated that such shifts were sporadic and unlikely to account for significant errors due to the fieldwalking. However, it is possible that a combination of these factors contributed to intermittent patches of localised anisotropy. An example may be seen in Figure 90, where

successive positive squares in Line 10 are most likely the result of recovery bias, especially since these units were on the topographically uniform takyr surface. However, such small-scale results do not explain the broad banding patterns evident elsewhere in the survey area, and both archaeological and geomorphological factors are likely responsible (see below).

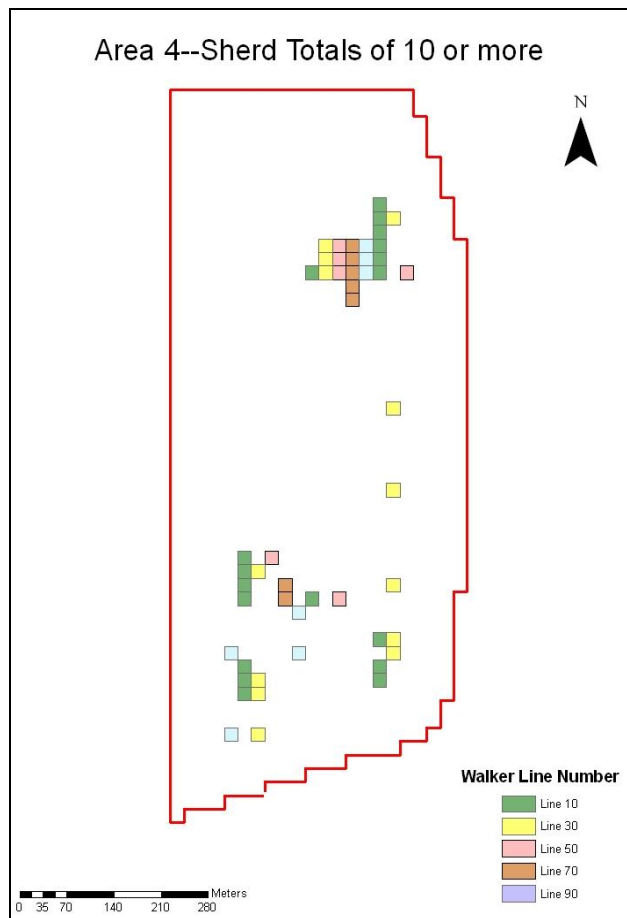


Figure 90. Sherd recovery rates for walkers in Area 4.

6.5.2. Variography

In order to investigate both isotropic and anisotropic patterns of material distribution more closely, we now turn to the geostatistical method known as variography. Geostatistics in general are well known in geological fields, primarily in mining contexts, but have rarely been applied in archaeology (Bevan and Conolly 2008; Lloyd 2004). Variography, essentially the first step in the process of interpolation known as kriging, examines the degree of variance within the values of a marked point pattern (i.e. one with numerical attribute values). The relationship between the variance between point-pairs (in this case individual sherds) and the distance between them

can be demonstrated using variograms (see below). These may be omni-directional, in which the only consideration is the distance (or lag) between the point pairs (Gringarten 2001). Alternatively, variograms may be targeted to explore anisotropic effects by selecting a specific angle or angles for analysis. In a region such as the Murghab, where the predominant directionality of the landscape is determined by the dune ridges, this kind of anisotropic investigation can prove useful in examining the degree to which geomorphology, settlement, or other factors may have influenced the ultimate distribution of surface pottery, either prior to or after deposition.

In order to provide a statistical assessment of the anisotropy in the underlying geomorphology, the semi-variance of the ASTER imagery was examined. The Quickbird imagery was not included in the analysis due to the substantial computational demands of the imagery and the fact that visual anisotropy was less evident than in the ASTER imagery (see Chapter 4). To reduce the potential for redundancy in the data the imagery was reduced to its first and second principal components, as higher PCs contained significant background noise. This process was run twice: once on the full 9-band image and once using only the SWIR bands. The results of these analyses are shown in Figure 91. The expected north-south anisotropy was not clearly evident in the full ASTER image, but did tend to be fairly prominent in the first PC of the infrared bands (red highlight). This finding supports the results of the PCA in Chapter 4 that indicated that the SWIR bands were more effective at isolating underlying geomorphology. There is also some evidence of correlation in the NNE direction (30°), although this was difficult to account for visually and may be partially attributable to edge effects of the irregular boundary. There were additional factors that detracted from a clear north-south anisotropy, and an examination of the variogram for Area 2 showed clear anisotropic patterning in the direction of the road and pipeline, indicating that modern activity can significantly affect the spectral signatures used to identify anisotropy.

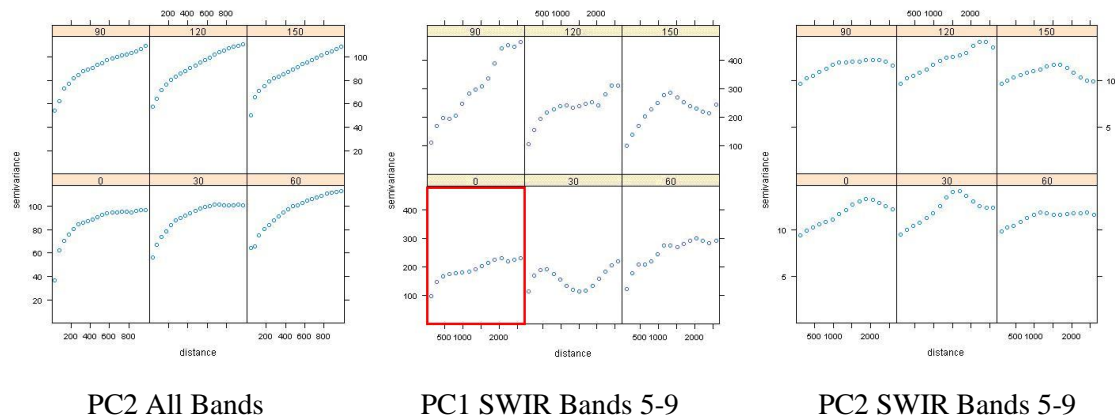


Figure 91. Directional Variograms of the ASTER Imagery within the NMDS Survey Boundary.

Ultimately, this analysis revealed little about specific geomorphological patterning beyond the fact that natural factors generally present a north-south anisotropy, although strong spatial dependence was subject to many mitigating factors. One reason may be that, while there is certainly ridging evident in the landscape, the geomorphology is complex and variable. As noted in Chapter 1, dune alignment is very uneven in this transitional zone, and the extensive longitudinal barchan dunes that may be expected to have more of a directional signature are generally absent in this part of the delta (see section 1.9). The improved detection of north-south anisotropy in the SWIR bands was possibly attributable in part to their lower spatial resolution, which may mask some of the local variation. There may also be a legitimate spectral component as well. Although the PCA analysis conducted in Chapter 4 employed a combination of ASTER and Quickbird imagery, and cannot be directly compared, the prominence of the dune features in the second principal component of the Aster/Quickbird stack indicates a significant contribution of the SWIR rather than the visible bands (section 4.3.3), and is supported by the current analysis.

Having gained a sense of statistical directionality in the landscape, the next step was to investigate the anisotropic patterning of the archaeological material. Since the analysis requires a ‘marked point pattern’, where each point has an intrinsic value, the centroids of each collection unit were used. Spatial lags (distances) were measured from a minimum of 20m to a maximum of 500m at 20m increments. The dataset, however, presents a particular difficulty with respect to variographic analysis. The highly disproportionate number of zero-valued squares creates a heavily skewed distribution, which can produce unreliable results (Bevan and Conolly 2008). Standard methods of normalising the data, which often include taking the logarithm, are less

effective in this case because the data remain heavily skewed (and also demand that we add one to all values before logging to avoid excluding logarithms of zero). Certain methods, such as Poisson kriging, have recently been applied to archaeological spatial patterning (Bevan and Conolly 2008), although the method is ideally suited for rates rather than raw counts and less applicable to the standard collection units in the NMDS survey (Goovaerts, pers. comm.). Goovaerts (2009) has suggested that indicator kriging may be useful in heavily skewed environmental distributions, although this method was beyond the scope of this research. For the purposes of this analysis, two types of point patterns were examined—the first containing all data including zero values but with a square root transformation to reduce the skew, and the second containing only positive valued collection units. This second method, while non-systematic in its exclusion of low-valued units, was useful in reducing the extreme skew of the dataset. Since low values could now be represented as collection units with 1 or 2 sherds, it was much easier to discern the anisotropic signatures that were otherwise masked by the enormous preponderance of zero-values. Moreover, this modification offered the chance to learn more about the spatial dependence of medium and high-density areas at larger distances that may have otherwise been undetectable.

The analysis employs a top-down approach, beginning first with the entire survey area then narrowing the analytical window to examine the individual patterns in different portions of the region. Figure 92 shows a graph of the semi-variance over the entire NMDS survey area. At extremely close ranges, a strong ‘nugget effect’ can be seen in the variograms, influenced by significant variance even within the clusters themselves (Lloyd 2004), and there is a clear, if irregular, decrease in spatial dependence over larger distances. The variogram surface for the positive collection units alone proved to be much more informative than did the zero-inclusive dataset, which was heavily skewed by the extreme prevalence of empty collection units. Very little difference was evident between the results for the entire area and those for Area 1, again indicating the statistical predominance of the Egri Bogaz 4 settlement environment in the statistical patterning.

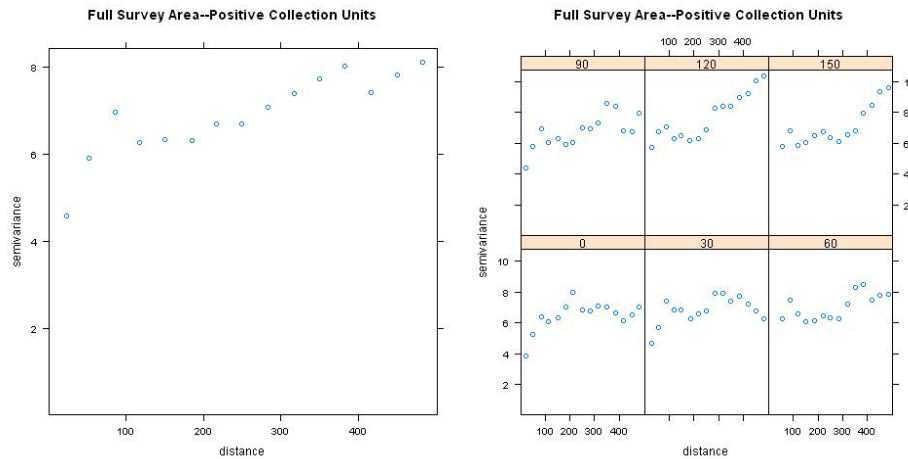


Figure 92. Variograms of the NMDS Survey Area (Positive Sherd Counts, Sqrt of Total)
Left: Omnidirectional variogram *Right:* Directional Variograms. 0° corresponds to north-south and 90° corresponds to east-west.

In order to look more closely at the Area 1 anisotropy, a variogram surface may be used (Figure 93). While some slight banding is evident in the N-S direction, indicated by the light blues and whites, the strongest directional influence appears to be to the NNE beyond about 150m. Clearly, several concurrent anisotropic influences are at work in this area, although teasing them apart is difficult. There is some indication of N-S anisotropy at extremely close ranges (the small, darker pink band in centre of diagram) and it possible that recovery bias in the fieldwalking is contributing to the spatial patterning at these extremely near distances, although similar orientation in the geomorphology is potentially a more significant factor. At slightly higher distances, anisotropy is extremely variable, probably reflective of the patchy but dense sherd cover and varied geomorphology in Area 1. Beyond about 150m, however, there is a pronounced shift to a SSW-NNE orientation. The prominence of this direction is striking, and is supported by the general orientation of some of the moderate sherd aggregations west of Egri Bogaz 4. In conjunction with the fact that these patterns run against the prevailing geomorphology, there may be some indication of an actual occupational phenomenon, possibly determined both by proximity to water as well as accessibility to the main settlement area (see also section 7.4.4, Figure 100). Such a possibility is highly speculative based on discontinuous surface scatters, however. Moreover, the hint of similar directionality in the ASTER imagery noted above, albeit much less clear, suggests that some of this anisotropy may simply follow the exposed takyr surface.

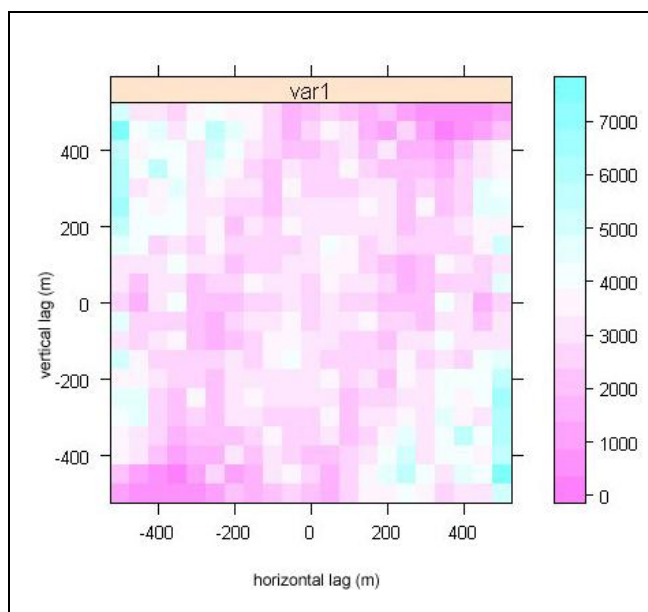


Figure 93. Variogram Surface for Area 1 (Positive Sherds, Square Root of Sherd Total)

It is probable that, at all distances, the alignment of the dunes contributes at least in part to the broadly north-south character of spatial dependence. However, it is interesting that a north-south anisotropic signature is not more clearly represented, especially given the obvious striping in the west of Area 1, addressed at the beginning of this section. In order to better understand the anisotropic processes going on in this particular region, Area 1 was divided into two parts, an eastern ‘half’ which comprised the majority of the high density areas associated with Egri Bogaz 4, and a western ‘half’ comprising the remainder of the area, composed largely of lower density clusters discussed in Chapter 4. The dividing line, a north south boundary, was selected according to a visual assessment of an apparent drop-off in sherd density. Because of the reduced size of the analytical regions, reliable data was only available up to 190m in the western portion, and 150m in the eastern one. The results suggest that the anisotropic patterning is completely different in each portion of Area 1. In the east, the variogram was generally isotropic although highly variable. In the west, however, anisotropy was strongest in a SSE-NNW direction, corresponding nicely with the pattern seen for the entire survey area and indicating an underlying geomorphological trend that was largely superseded by the main settlement area.

In order to investigate the anisotropic effects of the off-site regions, the highest density zones of Area 1 and Area 4 were removed from the analysis. The result, shown in Figure 94, was striking. Once the overwhelming effects of the main settlement areas were removed, the overall NNW-SSE anisotropy throughout the NMDS region came into clearer focus, showing generally strong spatial dependence through about 300-400m. Without the overwhelming effects of the

heavy distributions, the evidence clearly indicates an anisotropic landscape, but the apparent NNW-SSE orientation may suggest that the patterning is less influenced by the dune alignment than by the underlying fluvial geomorphology, evident in the large takyr regions. Beyond about 350m the anisotropic influences weakened, suggesting that the geomorphological processes that may have contributed to the dispersal of material were spatially restricted. It is, perhaps, significant that this spatial limitation broadly corresponds with the results of the earlier spatial analysis, and it is possible that this is reflective of some modularity in the settlement pattern, which may find support in the fairly discrete, linear orientations of diagnostic sherds in the western part of the survey area. However, there are other processes that may contribute to the spatial threshold as well. As indicated in earlier chapters, the extended longitudinal dunes that characterise the northeastern portion of the delta are much less prominent in the survey area, giving way instead to variable dunes and smaller hillocks that may ultimately obscure clear directionality, and similar intermittent sands can also obstruct the patterns caused by fluvial processes. Moreover, although the palaeodelta is generally oriented to the NNW, there is no reason to assume that natural channels all followed the same trajectory, so even alignment along fluvial systems may not show an anisotropic signature at longer distances. The anisotropy at short to medium distances is significant, however, and suggests the strong influence of both fluvial influences as well as recovery bias on the material distribution in the landscape.

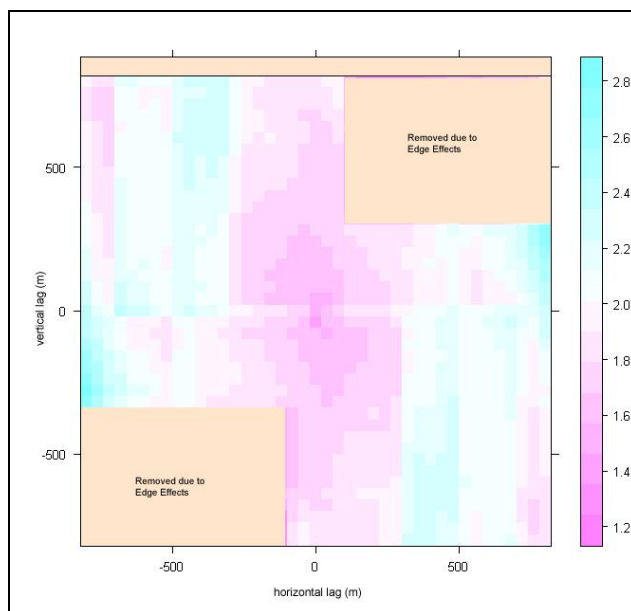


Figure 94. Offsite Anisotropy

6.5.3. Angular Wavelet Analysis

While the preceding analysis suggests that several factors have contributed to anisotropy in the survey area, there were some limitations to the variographic approach. While anisotropy can be studied, each direction must be specifically selected for analysis. In order to explore anisotropy more closely with particular reference to the collected materials, a process known as ‘angular wavelet analysis’ was employed (for discussion see Rosenberg 2004). This process effectively offers a way of measuring anisotropy continuously from 0° to 180° (higher angles simply represent the opposite direction so are not included). Essentially, the process fits a scalable ‘wavelet’, or windowing function, along each angular transect. It then assesses the variance in the angles between points against the expected variance using Monte Carlo simulations, which allows statistical significance to be determined. The process is ideally suited for the survey material, where each sherd represents a valueless point. To prepare the data for analysis, collection units with diagnostic materials were treated as single points in the point pattern. This method effectively eliminated any random angles that could be generated between sherds at close range. Rosenberg (2004) has noted that edge effects may have a distorting role in the analysis, so to remove boundary irregularities, two rectangles were identified for comparison. The first, representing the north of the survey area, comprised survey grids F,G and H, and was limited to a distance of 500m, the diameter of a single survey grid. This distance restriction removed the potential for false east-west anisotropy due to the boundary length exceeding the width. A similar rectangular region was identified for the western portion of the survey area, and comprised Grids L, M, and portions of D and E (Figure 95).

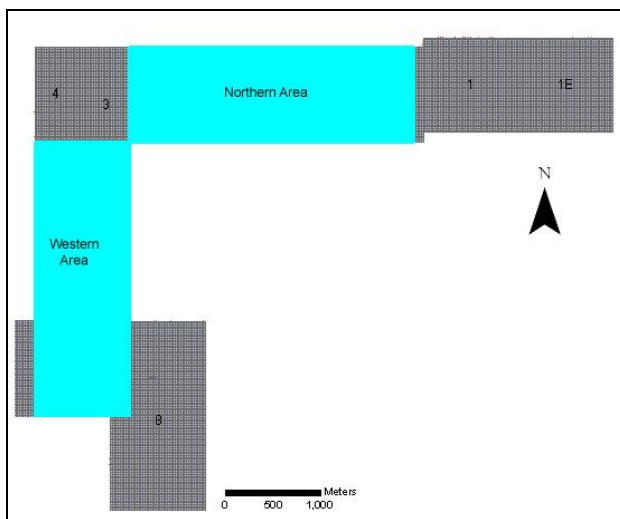


Figure 95. Analytical Regions for Angular Wavelet Analysis

Figure 96 shows a comparison between the wavelet analysis in the northern and western regions. Immediately apparent is the significant anisotropic difference between the two areas. In the west, spikes at 90 degrees (N-S) are prominent. Since the method does not offer the possibility to examine the anisotropy in incremental distance bands, the maximum distance was lowered incrementally to determine whether different distances had any effect on directionality. Interestingly, below 200m, the preponderance of 90-degree angles in the western offsite region nearly vanishes, with the closest spike occurring at about 110 degrees. There is some question of reliability, however, as the distance reduction resulted in far fewer point-pairs, so the pattern must be interpreted with caution. Moreover, similar spikes occur towards 180 degrees. However, even if the spikes cannot be completely trusted, it does appear that there is a legitimate case to be made for a shift from N-S to NNW-SSE as distance decreases, a finding that is concurrent with the variographic evidence.

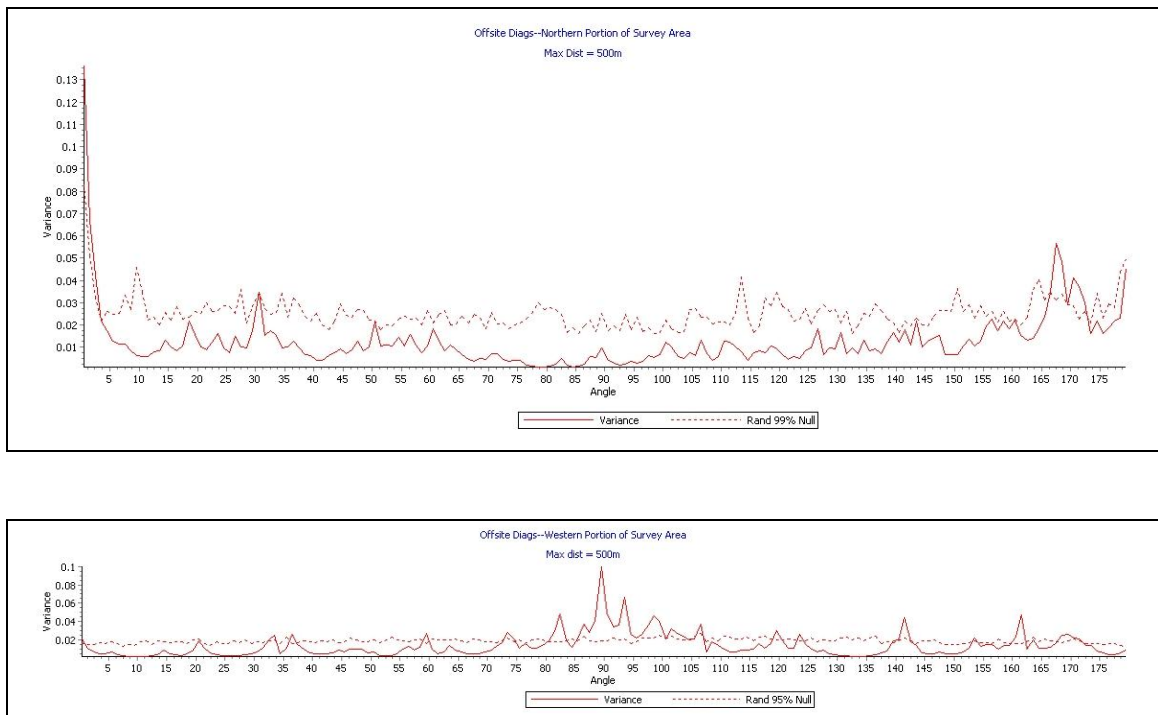


Figure 96. Comparative Wavelet Analysis for Offsite Regions. *Top:* Northern region. Note the spikes at 170° (corresponding to the road) and 0°. *Bottom:* Western region. Note the range of high values from 90°-100°, reflecting the underlying geomorphology.

The northern part of the survey area, however, exhibits a completely different anisotropic character. Here, the directionality tends towards the horizontal rather than the vertical, with peaks around 0 degrees. The apparent horizontal directionality described above certainly plays a

role, but in order to determine what processes are actually at work it is useful to try to deconstruct the anisotropy by period. Unfortunately, there were not enough diagnostics in either the Bronze Age or the later periods to offer a very clean depiction of angular variance, as indicated by the substantial fluctuations in the graphs. However, there are some distinct trends worth exploring. The first is that, for Bronze Age diagnostics, there is no statistically significant anisotropy in this particular region, suggesting that neither fluvial processes nor significant recovery biases from the dunes significantly impacted recovery. Of course, a few dozen diagnostics is a very small sample, but when viewed in light of the variograms described above, it is clear that the north-south directional variance is not nearly as strong a factor as in either the western survey area or the western portion of Area 1.

If no strong anisotropic signature is evident for the Bronze Age diagnostics in the northern portion of the survey area, the prospects improve for the late period materials. Here, a much stronger east-west anisotropy could be detected, with a secondary spike around 165-170°. This angle corresponds directly with the road and pipeline, and the occurrence of late period sherds both at the edge of the road and in the pipeline fill certainly contributes to a recovery bias in this direction. However, a closer look at the material distribution suggests that there are processes that are not so easily explained by these recent projects. A map of the distribution of glazed sherds, datable to the early Islamic period, shows that these fragments tend to follow a general east-west trajectory. There is a clear correlation between several of these sherd fragments and a long, winding track approximately 1 km south of the main road (Figure 97). Although the diagnostic sherds along this road are sparse—less than ten were recovered—the pattern is evident, and stretches for several kilometres. When viewed in association with the more general east-west anisotropy, it is quite possible that this road represents the continued use of a much older trackway, and other quasi-linear dispersals of Islamic period ceramics have been known to occur elsewhere in the delta (T. Williams, pers. comm.). Also noteworthy is the occurrence of this track just north of a later-period site on the takyr, briefly addressed in Chapter 5. Although only a single glazed sherd was found in that particular concentration, the chronology of the fragments suggests a Sasanian date for the foundation of the settlement, which most likely continued into the Islamic period. The presence of the wells (section 5.6.3.), at least two of which are clearly out of use, offers some evidence that this pattern of ceramics may signify a fairly significant east-west trading corridor with at least one easily accessible waystation in the area. If this is the case, it is interesting when viewed in conjunction with the more north-south orientation of materials in the western portion of the survey area, and perhaps particularly with

the 'kiln site' discussed earlier. It is possible that the survey area happens to coincide with a crossing of Islamic period trading routes, quite possibly originating during the middle Sasanian period or even earlier. However, further analysis of Islamic period trading routes falls beyond the scope of this research; moreover, the narrow width of the western portion of the survey area restricts a full examination of the material distribution in the east-west direction. The possibility, then, of additional parallel routes cannot be ruled out, and there is no reason to assume that this particular distribution of Islamic sherds necessarily represents a major east-west corridor.



Figure 97. Distribution of Green Glazed Sherds in Area 2

The predominant NNW-SSE orientation of the surface scatter suggests that anisotropic factors play a significant role in the NMDS surface distribution. Assessing the contributing factors to this directionality, however, is difficult. At short distances, anisotropic signatures are less readable, suggesting that in areas of high density, phenomena associated with occupation, or simply extreme local variability, may supersede either recovery or geomorphological factors that

become more prominent towards the periphery of these scatters. This possibility aligns with the findings of Bevan and Conolly (2008), who have demonstrated that anisotropic factors contributing to the material distribution on the Greek island of Antikythera were more discernible at higher distances, largely influenced by the geology of the region.

The second consideration deals with recovery bias. As noted above, the observable banding does not appear to be readily explainable by fieldwalking bias alone, although this may be a contributing factor. A second, and more likely contributing factor is the dune landscape. While generally oriented north-south, the interplay with the fluvial system suggests that the actual dune geomorphology is much more complex, and it would be incautious to rule out the ridging as a significant contributing factor. Unfortunately, it is difficult to separate the dune morphology from the alluvial processes in this environment. As Lioubimitseva (2003) has noted, alluvial geomorphology and the overlying dune ridges do not necessarily occur independently of each other, as can be seen in the occasional aeolian accretions apparently associated with fluvial features. It is therefore likely that a north-south component of both features may contribute to the anisotropy.

A third, and distinctly related factor, may be related directly to occupation. Settlement along a fluvial system, however, may be expected to exhibit similar anisotropy as the geomorphology itself, so it is difficult to discern definitively. There is some indication that, at least in the larger area of occupation in Area 1, such directionality may be less of a factor in the central area of settlement than in the western periphery of occupation. While speculative, such a pattern may indicate that on-site distributions, while clearly affected by post-depositional processes, offer some vestigial patterning from activities related to community structure and organisation. The increased anisotropy in peripheral areas may therefore reflect a greater responsiveness to geomorphology, not only in terms of fluvial processes involved in post-deposition, but also in the nature of actual occupation or land use.

6.6. Summary

A problem with statistical interpretations, and perhaps legitimate fodder for post-processual criticism of such methods, is a tendency for non-statisticians to equate probability with absolutes. It is all too easy for archaeologists, lulled and perhaps intimidated by these abstract values, to unquestioningly accept and pass on these mathematical reductions of complex

archaeological phenomena. The results of the NMDS spatial analysis clearly show the folly in jumping to such conclusions. Many of the earlier forms of spatial statistic explored in this chapter were fairly limited in what they could determine about natural and anthropogenic processes; and moreover, as evidenced by the similarities between the visual representation of the surface ceramics and the statistical renderings, a great deal can be gleaned from simply looking at the point patterns. So to what extent, then, can spatial analysis of the sherd distribution offer anything that cannot be identified visually?

The answer to this question lies in the ability of statistics to both confirm and probe. The lack of clearly identifiable surface features, even in areas of high sherd concentration, means that the identification of settlement in most cases can only be inferred through the character of the material scatter. By employing a combination of statistical techniques, these scatters can be quantified enough to determine whether they represent a significant departure from the background distributions, and thereby suggest targets for further analysis that may be more difficult to pinpoint visually. Moreover, spatial analysis can provide a standardised and repeatable method for identifying statistically significant aggregations and boundaries—both of which would otherwise be arbitrary and, as is the case in so many of the Murghab sites, subject to individual perceptual bias. Ultimately, the juxtaposition of cluster analysis and anisotropic investigations suggests that different kinds of patterning exist over the relatively small NMDS survey area, and that the continuous variability of these patterns means that categories such as ‘on-site’ and ‘off-site’ are too simplistic to capture these widely varied behaviours, or at least need careful definition analytically rather than identification from the outset. By employing these methods together with visual analysis, however, spatial behaviours were detectable in the material distribution.

Having now joined both qualitative and quantitative aspects of the material distribution, we are now confronted with a dataset that, while still complex, is far less intimidating. Rather than a seemingly chaotic set of material in a landscape completely resistant to archaeological recovery, the material can now be seen more clearly as a result of natural and human processes that can be explored. The following chapter seeks to evaluate these processes as they relate to a particular settlement landscape, the ultimate objective of this research. As such, archaeological enquiry will be the primary focus, but set within the context of the geomorphological and recovery issues laid out during the course of this thesis.

Chapter 7. Discussion: Re-examining Settlement in the Northern Murghab

7.1. Overview

The preceding chapters have examined the character of the material distribution in the Murghab study area as comprehensively as possible while avoiding overly confining classifications. With this restriction as an underlying theme, Chapter 4 offered an assessment of the current landscape with respect both to the underlying geomorphology and visibility issues. It then drew on remote sensing data to derive a series of partially abstract, quantifiable models against which to situate the archaeological evidence. Chapter 5 presented the survey data, examining qualitative aspects of the material distribution within the formidable interpretative barriers laid out in the previous chapter. Chapter 6 then broadened the scope to an examination of the spatial characteristics of the distribution, and attempted to present some measurable settlement entities and examine the ways in which the conceptions of these may change at different analytical scales. The task at hand is to shift from the observable data to a broader understanding of the actual nature of Bronze Age settlement in the northern Murghab delta. The discussion below necessarily begins by examining in detail the degree to which the NMDS data supports the models that have been traditionally employed to explain the Murghab phenomenon.

7.2. Surface Pottery in a Dynamic Landscape

Before delving fully into the Bronze Age settlement landscape, however, it is necessary to first review the archaeological landscape as it stands today, the end product of a complex and changing sequence of geomorphological and other post-depositional processes. As shown in Chapters 4 and 5, the relationship between the exposed takyr and settlement has been clearly overstated in the existing literature. Even in Area 4, where material comprised much of the takyr surface, the subsurface investigations indicated that surface scatters here were likely the result of erosion of material from an obstructed site immediately to the east. Elsewhere, broad, open takyr bore little relationship to actual settlement, and occasional sherds in these areas were detectable merely as a result of increased visibility. Despite the weak correlation between unvegetated takyr and occupation, however, the story is markedly different for eroded takyr surfaces, which account for a significant portion of surface material. It is therefore instructive to

explore in more detail patterns of aggregation to see if something may be learned about both post-depositional processes and, if possible, about the nature of the initial settlement patterns.

While the takyr in the Murghab are often assumed to reflect alluvial surfaces associated with the palaeodelta, it is simplistic to treat them as convenient windows of exposure onto a static Bronze Age landscape. In reality, takyr are highly dynamic geomorphological features (Fleskins *et al.* 2007; Suslov 1961). A host of processes, both natural and anthropogenic, may affect these features, and may ultimately impact the material deposition on their surfaces. Fleskins (2007) notes that takyr have been a central source of inexpensive and easily obtainable fresh water for centuries, and scatters of Islamic pottery have been discovered in small takyr-like depressions in other locations throughout the Karakum (P. Wordsworth, pers. comm.). It is certainly reasonable, then, that movements of humans and livestock over fairly small, concentrated areas have resulted in both redistribution and further fragmentation of surface material (Taylor *et al.* 2000). Of even greater significance, perhaps, may be the natural processes that characterise takyr surfaces. Of these factors, two are worth exploring in some detail. The first is surface water run-off. The hard clayey takyr crust is the prime factor contributing to a low-drainage environment. Fleskins has shown that, on unvegetated takyr surfaces, as much as 71% of surface water remains on the takyr surface after drainage, enough to be 'harvested' for agro-pastoral purposes or for drinking water (Fleskins *et al.* 2007). Although rainfall is uncommon in the northern Murghab, it is quite possible that heavier rainstorms, particularly in the spring, may contribute to the displacement of material in the direction of the surface runoff. Test pits in Area 4 indicated a gradual slope to the east, so material shifted by water may have a tendency to drift in this direction. It must be stressed, though, that such a hypothesis is based on data from a single takyr and cannot be treated as a definitive conclusion. Moreover, the flat terrain suggests that drainage processes would be slow, so the actual potential for run-off associated redeposition may be weak.

A related process, and one that may affect surface distributions more directly, is the erosion of the takyr surface itself, well documented in the Karakum (Suslov 1961; Lioubitsemeva 2003) and clearly observable in the field. Takyrs are highly susceptible to wind-based erosion, resulting in the deflation of the surface and consequent accumulation of local and wind-borne deposits (Argaman 2006). Similar to the accretion of sands and vegetation discussed in Chapter 5, the resulting build up of material tends to capture water which results in the development of vegetation. This process further traps wind-blown material, and a cycle of depositional processes ensues. As surface run-off is also dramatically reduced by this process (see Fleskins *et*

al. 2007), some stabilisation of surface materials may result as well. Moreover, wind-blown sand accretion may be more pronounced in boundary areas between takyr and dune ridges. This may result in part from moisture becoming trapped in these slightly lower-lying, transitional regions. Also, the proximity of these boundary zones to sand ridges themselves suggests that aeolian deposits are more likely to be deposited in these regions as a result of the interaction between wind and dunes. It is therefore reasonable to attribute the deposition of material on the eroded takyr perimeter largely to relatively recent geomorphological processes.

In dune environments, material dispersion consisted primarily of isolated sherds. Occasional diagnostics or small finds, in general, were not associated with significant assemblages, although exceptions may be found in the more concentrated aggregations in sandy depressions, discussed in more detail below. Given the extremely low densities in these areas, it is difficult to identify any particular post-depositional processes that may account for these materials, and it seems likely that a combination of wind or water-driven processes, or even sporadic collection and discard, may account for their presence rather than any systematic settlement pattern or field process. The paucity of occupational evidence on dune surfaces has been noted elsewhere (Cattani and Salvatori 2008), although an exception may be found in the scatters of ‘Andronovo’ type coarsewares, commonly found on sand dunes and attributed to later movements of steppe nomadic groups after the processes of desertification were well underway during the Final Bronze Age (Cattani *et al.* 2008b).

7.3 Revisiting the Oasis Model

The theoretical underpinnings of the oasis model have already been discussed in Chapter 2, although it should be mentioned that, in a sense, the NMDS survey at just 11 km² operates at the wrong scale to adequately assess a model meant to interpret the entire delta. There are, however, some key inferences that can be drawn from the data that suggest that the traditional oasis model is far too simplistic to accurately describe the Bronze Age settlement pattern in the delta. The first is the continuity of the surface material apparent in both the NMDS and AMMD projects, the complexities of which will be discussed below. While the contention of several AMMD researchers that the ongoing distribution of material represents continuous settlement (Cattani and Salvatori 2008) or farmland (Cleuziou *et al.* 1998) is questionable (see section 2.4), the results of this research strongly suggest that actual settlement processes were at work in the intermediate zones between larger occupational areas (e.g. Area 2; see section 5.6.3).

A second feature that calls the oasis model into question is the long and at least partially continuous distribution of material in the western portion of the survey area (see Chapters 5 and 6). The survey in this area represents one of the few substantial examinations of the 'empty' region south of the Kelleli-Egri Bogaz line (Cattani and Salvatori 2008). The presence of apparent, if small scale, settlement in Area 5 is interesting in light of several scatters (AMMD 961, 962, 966) discovered along a transect conducted in the mid-1990s between Egri Bogaz 4 and Taip (Cattani and Salvatori 2008), which bypassed the survey area a few kilometres to the south (Figure 98). At least one region along this transect, although not designated as a specific site, is described as containing dense Late Bronze material, and appears to extend the NMDS pattern a few kilometres to the south. Perhaps even more significant is the line of sites (963, 964, 965, 1083, 1084), themselves spanning a distance of over 3 km and continuing into the Adam Basan settlement area. With the exception of AMMD 963, designated as a 'type 1' depe with Middle and Late Bronze material, these sites are assigned to the Late Bronze Age, although such designations based on small surface distributions are, as has been noted, questionable. This clear evidence of linearity extending south from the survey area suggests that these scatters may be part of the same channel system or systems that watered the sites in the western portion of the NMDS survey area. The juxtaposition of findings of both surveys therefore indicates a significant occupational continuity with respect to the Bronze Age fluvial system. While such alignments of small settlements do not alone refute the micro-oasis interpretation, the lack of clearly bounded and isolated regions suggests that the traditional model's emphasis on ecological restrictiveness may indeed be overstated. Moreover, it may be expected that, if the oasis model were accurate, evidence of it would be most prominent in the northern Murghab, since the distal portion of the alluvial fan would presumably exhibit the earliest signs of aeolian encroachment in the delta.

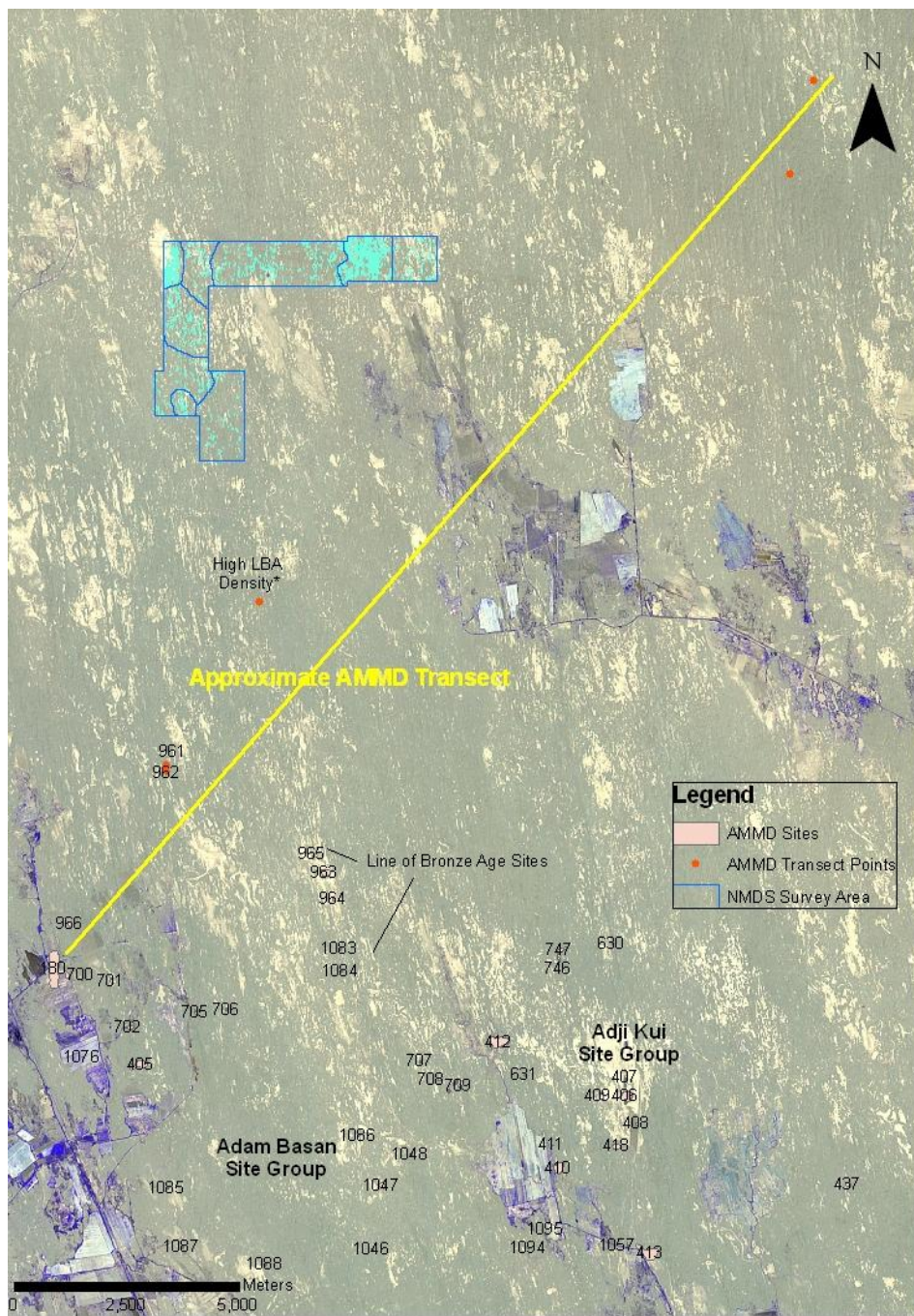


Figure 98. Taip-Egri Bogaz 4 transect (1994)

With respect to the chronological issues associated with the micro-oasis model, the NMDS research supports the findings of several scholars (e.g. Hiebert 1994a; Salvatori 2008b) that the model of a Middle Bronze northern delta and Late Bronze central delta is too simplistic. While the difficulties in ceramic identification have already been discussed (section 3.3), Middle Bronze materials are only part of the story. Late Bronze materials are also well represented, a finding supported by Cattani and Salvatori, who have recorded several scatters of mixed Middle

and Late Bronze material along various transects in the northern delta as elsewhere (Cattani and Salvatori 2008). Continuity into the final phase of the Bronze Age was less easy to identify, and Takhirbai-type materials were not readily identifiable in the field (see Section 5.9). However, the presence of at least one cluster of incised coarsewares as well as a single Yaz I sherd, both found in similar locations in Area 2, offers some evidence that at least limited occupation continued into the post-Namazga VI period. However, the presence of this material, while generally associated with the decline of the sedentary communities due to its appearance in contexts that date from the end of the Bronze Age (Hiebert *et al.* 2002), certainly does not in itself guarantee the presence of an associated sedentary occupation, and the failure of such material to occur in significant quantities within Area 1 raises questions regarding the extent to which the steppe presence was directly associated with the main occupation in this region.

There is therefore sufficient evidence to roundly question the categorisation of the Egri Bogaz settlements as a distinct and isolated micro-oasis. Indeed, their classification as such has perpetuated the skewed perception of an almost unsettled northern delta, a perception that is not substantiated by the data. However, as noted in Chapter 1, the rejection of an oasis-based settlement pattern does not necessitate the other extreme of a continuously settled, integrated and fertile alluvial plain, and between these broad conceptual frameworks lie any number of mid-level approaches. Prior to investigating more nuanced models, it is worth examining in detail some concepts of continuity, as manifested in the distribution of surface material.

7.4 Revisiting Continuous Settlement

The continuous model of Murghab settlement has already been discussed at length (see section 2.4.2.). To review briefly, the model posits a late 2nd millennium date for the onset of desertification, and ultimately diminishes the conventional interpretation of the Karakum sands as a barrier to settlement and movement during the Bronze Age. The hypothesised absence of this aeolian barrier allowed full exploitation of the deltaic alluvium, rich with fertile soils that were therefore available for cultivation (Cremaschi 1998; Salvatori 1998b), and evidence of this palaeo-landscape is indirectly detectable in the extensive material scatter evident in the long-range transects conducted throughout the delta. Sites have generally been attested where substantial surface material occurs, often in conjunction with topographical anomaly (Bondioli and Tosi 1998). The occurrence of both random scatters and more prominent depes or elevated

regions suggests to the researchers that vast areas of the delta were heavily occupied or at least open for significant agricultural activity (Cattani and Salvatori 2008).

Advocates of the continuous occupation model recognise that such patterns are not truly uniform, and these researchers have certainly not dismissed the linear characteristics of the delta-wide settlement pattern (e.g. Cattani and Salvatori 2008). However, the sheer geographical scope of their particular avenue of inquiry has precluded the possibility of looking more deeply at the nature of this continuity, with the exception of the few intensive surveys conducted as part of the AMMD projects (see section 2.4.2). The following discussion will examine continuity on several levels, beginning with an assessment of the material scatter, then shifting to more familiar concepts of occupation and settlement. By gradually broadening the analytical window, it will become possible to attain a better understanding of the intermediate scales of settlement en route to a larger goal: a better understanding of the nature of occupation in the northern Murghab.

7.4.1 Background Scatters

Perhaps it is best to begin by evaluating the NMDS material distribution through the lens of background scatter, a concept that is often invoked to describe the broad distribution of low-density ceramic material that may occur in off-site regions. Bintliff and Snodgrass (1988) describe this phenomenon in Aegean contexts as a ‘sherd carpet’ in which the distribution exhibits little or no discernible variation in density, effectively ruling out the presence of actual occupational areas or activity areas. This perceived uniformity of off-site material has been questioned by Alcock and Cherry (1994), who suggest that varied processes may be expected to affect such distributions in different ways. Kotsakis has observed some of this variability, noting that certain areas where off-site scatters may be expected do not always yield surface material (Kotsakis 1989, cited in Alcock *et al.* 1994). Moreover, the Boeotian data relied largely on basic sherd densities, and subtleties that may have been detectable through more intensive types of spatial analysis were not explored. In the NMDS survey, the surface scatter indicated broad variations both in land cover and material density, with the clearest evidence of clustering occurring in concentrated areas. Below a radius of about 50m, the minimum distance employed in the statistical analyses, the identification of sherd clusters was purely visual, and the tendency for these to occur in sandy depressions or eroded takyrs was evident from observation. Thus, at the smallest analytical scales, both aggregation and absence of material may be seen primarily as

the result of a highly capricious landscape where even a small accumulation of a few centimetres of wind-blown sand can obstruct a scatter of material that may otherwise be visible in an exposed patch of alluvium. At larger scales, however, there is evidence of other processes at work that cannot be explained simply by these localised occurrences, and these will be explored in more detail below.

In order to better understand the nature of this highly discontinuous background scatter, it is useful to explore some of the more traditional explanations for the presence of off-site material, and to evaluate the degree to which the NMDS surface distribution may support or refute these models. One of the more commonly cited rationales to account for background scatter is manuring (Wilkinson 1982). The widespread application of manure as fertiliser is well-established in antiquity (Bintliff and Snodgrass 1988), and Goldberg and Macphail (2006: 204-206) have noted that ploughsoils may contain anomalous anthropogenic deposits. Citing the rural late Roman site of Oakley in Suffolk, England, they observe charcoal, burnt flints, ash and other indicators of refuse in ploughmarks, reflecting the mixing of anthropogenic refuse in the manuring regimen. Wilkinson (1982), in turn, describes ‘night soils’, aggregations of refuse from cess-pits or other waste-removal activities often located on the outskirts of habitation regions, that likely became mixed with other artefacts over time. The acquisition and distribution of these materials as fertiliser therefore resulted in the widespread, if inadvertent, dispersal of surface sherds, which were then subject to further fragmentation over the millennia. The nearly continuous distribution of these materials observed by Wilkinson may extend from three to six kilometers radially, a distance could be reached within two hours’ haul (Wilkinson 1982: 326). Variability in the continuity of the scatter may be partially related in part to the orientation of field systems or available irrigation, as well as erosional processes such as gullyng. While the manuring hypothesis has been widely invoked to account for broad background scatters in diverse regions (Alcock et al. 1994; Bintliff and Snodgrass 1988), Alcock has criticised such broad and often uncritical applications of the theory. Although she does acknowledge that manuring may account for the deposition of at least some cultural material, and praises Wilkinson’s rigorous methodology, she cautions against invoking the hypothesis as a catch-all explanation for background scatters in highly varied and often untested regions.

In the Murghab, researchers have similarly attributed what they view as a continuous background scatter to manuring (e.g. Cleuziou 1998), although no specific test of the hypothesis in this particular region has been conducted. It is therefore necessary to investigate the degree to which the NMDS data substantiates such a theory. While the survey is not intended to be

directly comparable with Wilkinson's results, some broad assessments are possible that can shed light on the degree to which the model explains the sherd scatters in the survey area. By far the most apparent discrepancy between the NMDS survey and others in the Aegean and the Near East is in the magnitude of the background scatter. Wilkinson (1982: 331) estimates that the hinterland surrounding Tell Sweyhat, estimated at a 3km radius, may contain some 8-10 million sherds as a result of Bronze Age manuring practices, or over 177,000/km². Although Wilkinson's methodology (1982: 327) employed a more intensive strategy in each individual sampling unit, recording and collecting all material greater than 1cm, his estimates far exceed the observed sherd totals in the NMDS survey. Even in Area 1, the density averaged just over 14,000 sherds/km². If this estimate were scaled up by a factor of 5-10, representing the portion of the landscape unseen by the walker, counts increase to 70,000-140,000 sherds/km². While this measurement is not too far from Wilkinson's estimates, it should be noted that Area 1 represents a heavily occupied region, of which the majority of sherds fall in a small number of collection units. However, in the adjacent, less settled Areas 1E and 2, where counts are likely to be much more reliable, densities fell to only a few hundred sherds/km². Even taking the restricted visibility into account, these numbers are several orders of magnitude less than those described in the Near East. Moreover, in hyper-arid zones, such as coastal Oman, Wilkinson has documented sherd counts on the order of 2.5-10 sherds per square metre, the result of lag deposits that remain after the soils have been removed via deflation. The comparative absence of material in the Murghab, a region of similar aridity and high deflation, is striking and suggests that a continuous sherd scatter resulting from manuring may not be in evidence here. A further problem lies in the distribution of these materials. Broad takyr surfaces, meant to reflect the ancient alluvial surface, remain largely devoid of significant material scatter. It is difficult to ascertain the degree to which these surfaces were cultivated, although the test pits dug into the takyr surface, sometimes in regions of high sherd concentrations, did not provide any evidence of organic material that may be expected in heavily manured zones (Goldberg and Macphail 2006: 204). Given the current level of analysis, it would be impossible to claim with any convincing evidence that manuring processes were *not* occurring in the Murghab,¹² but it is an enormous logical leap to move from possibility to a primary explanation for spatial patterning. Rather than a blanket transposition of Aegean and Mesopotamian models onto the Murghab, it is more judicious to suggest that while manuring may have partially contributed to some surface scatters, such a process was likely to have been intermittent rather than continuous, and perhaps

¹² Alcock and Cherry (1994) acknowledge that manuring was quite likely a contributing factor to offsite scatter in the Aegean, but they question Bintliff and Snodgrass' reliance on the theory as the primary explanation for the surface scatters.

more intensive along channels or irrigation ditches. If this is the case, it may partially account for some of the directionality in the material distribution.

A second factor that may contribute to the background scatter is the chance discard or lateral displacement of materials by humans or animals. Although Bintliff and Snodgrass (1988) discount such processes from having a significant effect on the material distribution in Boeotia, the nomadic history of the Karakum demonstrates that the movement of humans and animals was widespread, even in the absence of sedentary occupation. Several broad expanses of sheep dung were found in the survey area, indicating that flocks may pass through regularly. Moreover, the occurrence of several individual small finds in isolated contexts may support chance discard of individual artefacts as part of pastoral and other mobile or semi-mobile practices. While such processes would hardly account for the presence of major aggregations of artefacts, they may have contributed to low-density scatters or isolated fragments offsite. The fairly common occurrence of isolated regions where several sherds from a single vessel occurred concurrently may offer further evidence of this process. While these ‘pot-smashes’ occurred primarily with late-period vessels, it is likely that similar processes affected Bronze Age pottery as well, both in modern times and in antiquity.

A third factor is that these background distributions reflect actual small-scale settlement processes or activities that may be expected to occur in the immediate vicinity of settlements, such as production or burial. In both Areas 1 and 4, the occurrence of sherds in conjunction with vitrified brick and slag suggest that some of the material is associated with kilns, and such a possibility is supported by the extent of the scatters near the excavated kilns on Egri Bogaz 1 and 2. Sherds may also be associated with burials (Wilkinson 1982), and the presence of substantial cemeteries at several Murghab sites suggests that similar activities may be in evidence in the NMDS region as well. In terms of actual occupation, the lack of substantial architectural material or small finds associated with these small scatters suggests that any occupation was likely to have been intermittent; short-term or transient processes that may have contributed to the material distribution. Perhaps the most common explanation for short-term habitation is seasonal settlement, although Foxhall (2000) criticises such a label as a convenient yet simplistic way to account for sparse assemblages of indeterminate origin. Although seasonality has been invoked to account for the smaller scatters in the Murghab (Cattani *et al.* 2008a: 44), there are problems with this explanation. Seasonal occupation is often linked with transhumance, where high pastures are sought out in summer, and protected valleys in the winter (Harris and Gosden 1996). Such strategies, however, are not applicable in the northern Murghab, where terrain is

essentially flat and relatively uniform. One possibility may be that short-term occupations were linked with local herding activities. Evidence at Gonur suggests that a substantial proportion of the Bronze Age economy was devoted to livestock breeding—primarily sheep and goat, and to a lesser extent cattle (Moore 1993; 1994). Although the actual location of pastureland cannot be determined from the current data, the mixed economy suggests that herding was most likely practiced within range of the urban centres, and it is possible that unused agricultural land may have seen a dual function as local pasture (Wilkinson 1993: 558). If this is the case, small scatters may not represent significant settlement at all, but vestiges of activities by local herders or farmers. Even today, occasional ash deposits can be seen on remote takyr, or sometimes within walking distance of agricultural fields, the remains of fires built by local herders. In this light, it is interesting to consider the presence of poor-quality, often blackened, sherds that occurred intermittently in Areas 1 and 2. These were of Namazga V-VI type and consequently associated with deltaic rather than steppe communities, although rare evidence of the latter does begin to occur in the region towards the end of the period (Cattani *et al.* 2008b for discussion). These scatters tended to occur in extremely low densities, suggesting that the association of these sparse coarsewares with significant settlement—even small-scale seasonal or periodic occupations—may be a stretch. More substantial aggregations, however, may be reflective of small-scale sedentarism.

Lastly, this already complex and varied dispersal of material is likely to have been further modified, perhaps substantially, by ongoing geomorphological processes. With respect to the small offsite scatters, erosion and deflation have likely contributed significantly to the surface distribution. Deflation is well documented in the Murghab (Rossi-Osmida 2007; Hiebert 1994a), and while it is often referenced in the literature in the context of deflated architecture, its impact on site surfaces is well established (Rosen 1986). Hiebert (1994a: 35) notes that the top 30cm of the Gonur North deep sounding consisted primarily of a mix of abraded sherd fragments amid yellowish-brown sandy deposits. While he attributes material on the surface primarily to wind-blown deposition, he associates the shallow subsurface mix of sand and cultural material primarily with deflation. In offsite depressions and takyr surfaces, complex deflationary processes are also plausible. In these low-lying areas, wind may erode finer materials, resulting in the dissolution of discrete stratigraphy. This process may result in the formation of ‘lag deposits’, aggregations of heavier material left behind by the removal of fine particles via wind erosion (Rick 2002). The result may be an unstratified palimpsest of large surface artefacts from different chronological periods, which may then be redeposited via further erosional processes, effectively confounding the archaeological landscape. Such processes may

partially account for the perception of some of the northern deltaic sites as single-period occupations, and it is quite possible that significant scatters removed from the major occupational areas, such as the large takyr-edge concentration in N-16 (see section 5.6.4.), may result in part from similar processes.

The above discussion illustrates that, rather than a passive ‘background’, the sherds represent highly complex and varied processes, which in turn vary from region to region. Clearly, small scale settlement and activities associated with such settlement account for at least some of the material, and these distributions are more substantial in the immediate peripheral zones beyond primary settlement areas. If practices of manuring and activities associated with pastoral activities are to be included in these processes, the implication is that these scatters are indicative of activities associated with mixed economic processes that decline at distances beyond two or three kilometres. Beyond these distances, as in Areas 3 and 8, the paucity of material suggests that activity is much more limited, and the occasional material in these regions is more likely to have resulted from isolated activities (see above) or chance discard. In all cases, however, these distributions have been heavily modified by complex geomorphological processes. These, over the past four millennia, have acted as the primary agents in determining the current character of the surface scatter.

7.4.2 Continuity and Settlement—Small Occupations

To this point, our examination of continuity has focused on the distribution of material directly observable in the landscape, and while there is clearly a large amount of what may be thought of as ‘offsite’ material, the scatters are not so much ‘continuous’ as variable and punctuated, and this patterning will be revisited in section 7.7 with respect to the fluvial system. At the next analytical level, and perhaps more difficult to conceptualise, is an analysis of continuity in relation to actual sites or settlements, which are largely conceptual and often not directly measurable (see discussion in section 2.7). Some information may be gleaned from the presence of medium-density sherd scatters distributed over several collection units, especially when these occur together with diagnostic material. The prevalence of such scatters suggests that small-scale occupations may have been commonplace. The largest of these occurs in close proximity to larger settlement areas, one example of which is the large scatter in H59. It is difficult, however, to determine the nature of these occupations, and there is no reason to assume that the scatters represent a uniform phenomenon even over a small area. Some possible explanations

for low-density scatters were addressed above, and in some cases, small scatters on the periphery of more substantial distributions may represent domestic occupations. Such settlements may account for the small aggregations that occur west of the predominant scatters in Area 1 and, while speculative, the possibility finds support elsewhere in the delta. Small domestic structures were discovered beyond the walls of the main buildings on Adjı Kui 1 (Salvatori 2002). The occurrence of domestic architecture has also been documented about 100m south of the monumental structure on Gonur North, where a substantial quantity of Namazga V domestic wares was discovered (Hiebert 1994a: 96-99). It is possible that the surface distribution in H59 represents a similar domestic context, whereas sparsely distributed, often coarser materials further afield indicate more transient occupation. In the western part of the survey area, similar Namazga V and VI materials along the survey corridor show no obvious evidence of differentiation, and material types were similar in Areas 5, 6 and 7. A possible picture, then, is one of relative cultural standardisation throughout the survey area, with the greatest differentiation in status occurring in the immediate vicinity of Egri Bogaz 4, where the range of material may reflect different levels of wealth and status, co-existing in close proximity. A possibly similar situation may be seen in the site of Altyn Depe, where evidence of specialist classes and social hierarchies is well-documented and seen as one of the hallmarks of the urbanising Namazga V period (Masson 1988, also see section 2.2). Such a possibility is only speculative, however, and it is very possible that differences in material relate to different functional uses rather than clearly stratified social groups.

7.4.3. Continuity and Settlement—Larger Occupations

Shifting the focus from these small entities to more heavily occupied zones raises new interpretative difficulties from the perspective of continuity. Because actual settlement boundaries are highly ambiguous, it is difficult to determine when to employ on-site or off-site interpretations, especially at the margins of high-density zones. Surveys that focus on individual sites are often highly intensive, requiring full, intensive sampling of a mound in order to locate specific areas of production, communal or other activity (see Cattani *et al.* 2008b; Vidale *et al.* 1998 for local examples). The NMDS survey, which relied on 20m collection units, employed too broad a scale to assess adequately highly localised occupational trends and activity areas. However, based on the convergence of surface and sub-surface observations, some initial conclusions may be drawn with respect to the continuity of material in more densely occupied regions. The first deals with topographical variation, and its relationship to the material

distribution. As may be expected, there was some relationship between occupation and mounded areas, indicated by the moderate density of large sherds on the surface of several mounds in Area 1. However, the significant depth of loose aeolian deposits devoid of cultural material suggests that the elevations of these mounds may be overstated, and evidence from the test pits (section 5.6) suggests that anthropogenic mounds may often be partially or wholly obstructed by sand. Material on the takyr was difficult to attribute directly to settlement since subsurface material was generally absent. While deflation may have played a role, the excellent preservation of many exposed sites in the delta suggests that substantial occupation would be detectable, although small settlements may have eroded away. There are several possibilities that may account for such aggregations of sherds in low-lying areas. The first of these is erosion from nearby settlement locations. However, there are other, anthropogenic processes that may be considered as well. Allison (1999: 21) discusses the concept of ‘secondary deposition’, by which artefacts are redeposited from their primary contexts. While natural processes are sometimes included in this terminology, Allison specifically notes the deposition of refuse in areas beyond actual habitation. Such processes may, at least in part, account for the presence of fairly large sherds in regions that do not appear to directly reflect habitation areas. Another possible anthropogenic explanation for these low-lying areas of high surface density may be that they were communal spaces or external courtyards. Such a feature has been identified at Altyn Depe, where Masson has identified a central square of approximately one hectare (Masson 1981). While this is a possibility, there are some significant problems with such an interpretation. Unlike the feature on Altyn Depe, the depressions in Area 1 appear to be natural, indicated by both the lack of cultural stratigraphy in the test pits as well as the fact that there is no significant topographic variation between these depressions and the surrounding takyr. It is possible that deflationary processes on the exposed takyr have erased evidence of occupation, and the cyclical process of takyr deflation and resurfacing discussed by Suslov (1961: 457) may have entrapped remnant cultural material in the immediate takyr subsurface. The presence of tiny fragments of cultural material intermixed with the takyr soils could provide some evidence for this process both in the areas north and west of Egri Bogaz 4. However, the lack of substantial cultural strata suggests that significant occupation was minimal.

7.4.4. Settlement Complexes in the Murghab

The scope and apparent complexity of occupation in Area 1 warrants further investigation. Too often, site characteristics are inferred simply from the size of the surface distribution and

location in the landscape. Essentially, the Egri Bogaz 4 concept requires a new interpretation. While the true characteristics of a settlement are difficult to extract based solely on surface scatter, there are clues that can be read from the pottery distribution. One concept that is beginning to surface in newer Murghab research is the ‘settlement complex’. This concept remains loosely defined, largely due to the continuing lack of sufficient regional studies. The original notion of the settlement complex in the Murghab is directly linked with the micro-oasis model, and used to represent a semi-isolated cluster of occupational areas (e.g. Sarianidi 1990; Udeumuradov 1993), usually separated by a few kilometres (see section 2.4). A modified use of the term, however, denotes a region of distributed mounds or other settlement areas—often associated with a central, and often fortified, occupation area. In a recent reassessment of the Togolok 1 site, Cattani observes that ‘this series of discrete entities (low mounds) seems actually to belong to a single large settlement, presumably no less than 60 hectares, which perhaps reveals the presence of a real, large-sized central place in the Margiana of the Late Bronze Age’ (Cattani *et al.* 2008a: 6). Hiebert, as well, notes the proximity between Togolok 1 and 24, and suggests that the relatively short distance separating these two sites, at less than 600m, represents just one section of a contiguous chain of occupation (Hiebert 1994a: 20). A similar phenomenon may exist at Taip, although the estimate for this complex is somewhat smaller, at 25 ha (Cattani *et al.* 2008a: 6). Although Adjı Kui escapes mention in this context, the recent work conducted by Rossi-Osmida suggests that settlement activity associated with Adjı Kui 1 and Adjı Kui 9, themselves separated by only a few hundred metres, was much more intensive than previously thought (Rossi-Osmida 2007: 33; but see criticism in Salvatori 2007). Although Salvatori (2002) dates Adjı Kui 1 to the Namazga VI period and Adjı Kui 9 to Namazga V, recent finds from the former may indicate an earlier date for the initial occupation of the former (G. Rossi-Osmida, pers. comm.). If this is the case, then there may be a plausible argument for partially contemporary occupation at both sites. Moreover, Rossi-Osmida's discovery of continuous surface sherds linking these two sites may further support this possibility—although this material has not been directly linked with occupation and may result primarily from erosion (Rossi-Osmida 2007:33; also see criticism in Salvatori 2007). The possibility of settlement complexes in the central delta is further supported by the tangential discovery of AKF3 during the current research (section 4.5.3). Here, in addition to the significant aggregations of large sherds on the depe, substantial diagnostic material was found on the surface of a takyr about 500m west of the site, in a scatter that comprised nearly a hectare. Further insight into the behaviour of a potential settlement complex may be seen in the experimental transects conducted between Togolok, Takhirbai and AMMD 55, which revealed significant fluctuations in ceramic densities well beyond the primary site location. As noted above, Cleuziou has attributed the

more significant peaks to small settlements, possibly farms, although he does acknowledge the complications associated with the overrepresentation of pottery on takyrs or sandy depressions (Cleuziou *et al.* 1998).

Settlement aggregations such as these are not restricted to the Murghab. At Shahdad, for example, a pattern of what Hakemi and Sajjedi view as horizontal rather than vertical stratigraphy has been attributed to occupational shifts as a means of coping with a changing and tenuous fluvial system (Hakemi and Sajjedi 1988). Another conceptual model may be seen in Titrish Hoyuk in Anatolia where, beyond the main settlement mound, Wilkinson has documented the presence of an outer town as well as outlying suburbs. Significantly, he notes that sites with a shorter period of occupation may spread out substantially (Algaze *et al.* 1992). Given that significant Bronze Age occupation in the northern Murghab most likely spanned no more than a few centuries (see sections 2.3.2., 5.8), such a pattern may be in evidence here. Additional parallels, albeit from an earlier period, may be found in the spatially expansive Chalcolithic settlements in much of the Near East. These communities were largely dispersed and may offer evidence of a shifting settlement pattern (Casana 2003; Parr 2003). Although these settlements represent a much longer occupational duration than the Murghab occupations, the similar dispersal of low-mounded settlement areas may offer some insight into early processes of urbanisation (for further discussion see below).

In this frame of reference, occupation in Area 1 may be better represented as a settlement process—a complex, quasi-linear chain of occupational areas that comprised a substantial area of occupation. Clearly, the published description of Egri Bogaz 4 as a discrete unit flanked by two small secondary sites is overly simplistic, and the focus on the site as a singular entity forces the rest of the archaeological landscape into the conceptual background. But what might such a complex look like? In this visually obstructed landscape, the actual scope of occupation is difficult to determine, but a general model may be proposed. The intensity and diversity of material in the centre of Area 1 indicates a primary settlement area comprising several hectares, although it is unlikely that this entire area was occupied. Secondary concentrations or activity areas are oriented approximately south to north, to the west of the main occupation area, likely following a watercourse (see section 7.7). Although neither the northern nor the southern extent of the Area 1 distribution is known, an additional transect just south of Area 1 confirmed the absence of substantial surface material south of Egri Bogaz 4. Therefore, settlement appears to have extended northwards rather than southwards, although it is possible that some of this material was transported by fluvial erosion.

While it is difficult to directly compare this area with others in the delta because of different survey methodologies some visual comparisons are possible. Figure 99 shows a comparison of sites in the Togolok area with settlement clusters in the Egri Bogaz 4 region. Immediately evident is the prevalence of sites aligned along a palaeochannel to the east of Togolok 1, comprising some 13 sites compared with 2 to the west of the main site. An additional 5 sites appear along the channel, or on its eastern side. The sites included in the purported complex extend north from site 197, 700m south of Togolok 1, to site 200 some 500m to the north—a overall range of some 1.2 km for the settlement group (Cattani *et al.* 2008a: 6). The rationale for including these particular sites and not others in the complex is not clear, however, and the inclusion of the fortified site of Togolok 21 (AMMD 196), for example, would extend the range another 300m to the south. Without intensive survey along this particular channel, however, it is not yet possible to determine the extent of any particular settlement string, and Masson has suggested that at least one continuous line of occupation may stretch up to 11 km along a proposed channel (Masson 1981).

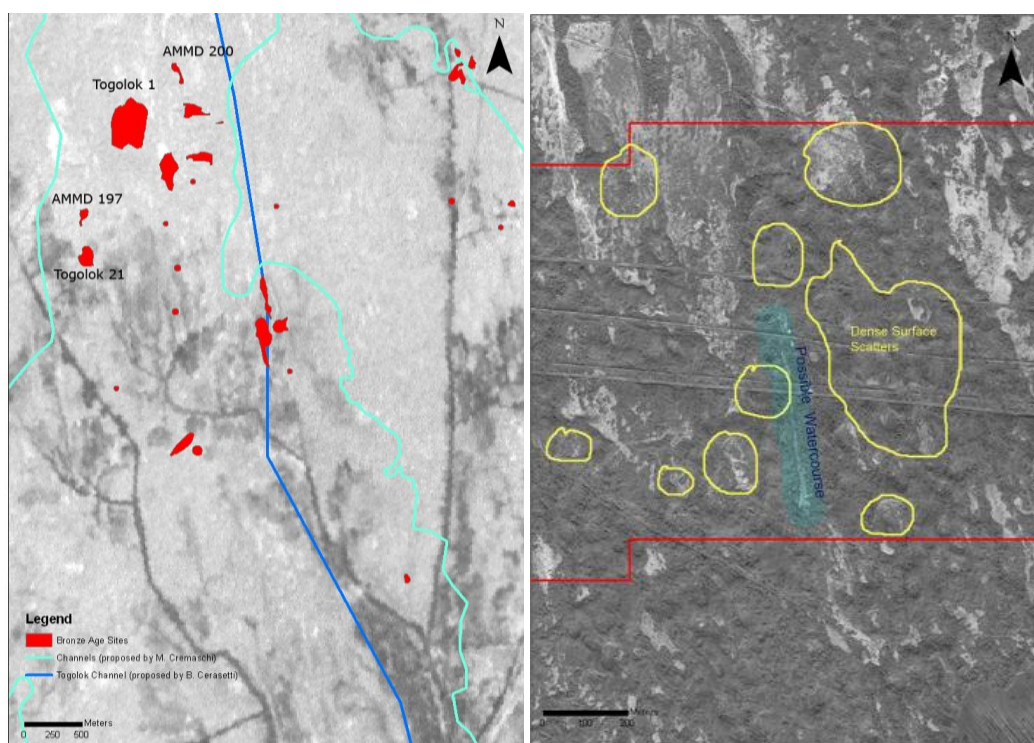


Figure 99. Comparative Settlement Complexes for Togolok and Egri Bogaz 4. *Left:* Togolok Region. *Right:* NMDS Survey Area. Settlement areas based on results of Gi* analysis at 50m threshold distance, $p < 0.00001$ (section 6.4.3).

7.5 *Isolation and Integration*

By treating the settlement pattern in Area 1 as a process, we can add several layers of complexity to the overall settlement pattern analysis and thus gain a deeper understanding of the role that this region may have played in the broader northern Murghab settlement pattern. It is difficult, however, to determine where such an assessment might begin. The sheer intensity and breadth of material in Area 1 denotes this area as a primary locus of regional occupation. Primacy itself, however, is a loaded term. In Murghab research, the concepts of primacy and centrality have been taken for granted—used either to denote provincial centres of isolated micro-oases (e.g. Sarianidi 1990), or as nodes in an integrated settlement hierarchy. Implicit in these traditional interpretations is a distinction between an urban centre, usually containing a large fortified structure, and some number of external rural, town or village sites (P'yankova 1994). In a recent interpretation of the Egri Bogaz site group based largely on Thiessen polygons, Egri Bogaz 1 has been proposed as a key regional centre during the Middle Bronze Age, shifting to Egri Bogaz 4 during the Late Bronze Age (Salvatori 2008a: 62, 65). The substantial presence of Namazga V materials in the survey area, however, calls this chronology into question. Furthermore, while no systematic study was conducted on the pottery from previous excavations on Egri Bogaz 1-3, a brief assessment by the author indicated several large Namazga VI-type fragments from Egri Bogaz 3. While these observations do not refute the possibility that the southern Egri Bogaz sites contained a substantial Middle Bronze occupation, the clear evidence for widespread Namazga V materials throughout the survey area substantially weakens the case for a shift of the occupational centre north from Egri Bogaz 1 to Egri Bogaz 4 in the Namazga VI period.

One useful framework that may be used to explore the relationship between the Area 1 occupation and the smaller settlement groups in the western survey area is that of rural-urban interaction, although to treat these as strictly dichotomous concepts may be too simplistic. The complex systemic nature of rural-urban interactions has become increasingly recognised not only with respect to understanding rural sites as sustaining communities for urban centres (Keatinge 1975), but as complex entities themselves (Schwartz and Falconer 1994). As Matthews observes, 'any study of [Mesopotamian] urbanism needs to look beyond the city walls as well as inside them in order to fully understand the nature of the life of common people.' (Matthews 2003: 182) In the Murghab, questions concerning urban and rural settlement have not been explored in depth, and, as noted in Chapter 1, the focus on large sites has tended to ignore most sites that may fall into the rural category. A further difficulty lies in defining what actually constitutes a 'rural' settlement. Small occupations in the eastern portion of Area 2 may

have existed within the hinterland of the Egri Bogaz 4 complex (see section 7.7), and while these may have contributed to the larger local economy of Egri Bogaz 4, the discontinuous nature of settlement may suggest that rural settlements sustained themselves through small-scale subsistence strategies. Similarly, the lack of material beyond the main concentrations in Area 4 may represent a sparsely populated region within the agricultural sphere of these smaller settlements. The lack of clearly identifiable small occupations in this latter area may indicate that substantial communities may have been more apt to develop within easy access to regional centres. Further support for such a conclusion may be found in the sparse zone of Area 8 where, in the absence of a significant centre of occupation, evidence for even small settlements—representing either populations associated with the larger sites or small groups already in the area—was significantly lower. However, the increased sherd densities suggest that there may have been substantial occupation just south of the survey area (extending southward from D70), although the extent of the sherd scatter could not be determined.

In the western portion of the survey area, detection of a rural-urban dichotomy is even more problematic. Surface scatters in this region, and the prevalence of Namazga V/VI diagnostic materials, indicate a line of small but probably permanent sedentary communities, well beyond the immediate sustaining area of the Area 1 occupations (see section 7.7.1). The degree to which urban or proto-urban complexity was manifested in these settlements cannot be determined, although the fact that these sites are only a few kilometres away from the more populated areas suggests that none of these occupations were extremely isolated. Furthermore, the results of the anisotropic investigations, discussed in section 6.5, may suggest that influence may have been transferred differently from community to community along the channel networks than across them, the significance of which will be discussed in more detail in section 7.7.

7.6 Interpreting the Settlement Pattern—Settlement Hierarchies

The preceding analysis has sought to better understand the continuum of surface material vis-à-vis actual patterns of occupation. The next step is to situate this discussion within the broader regional context of Murghab settlement. As discussed in section 2.4, a common theme that tends to appear in the Murghab, as elsewhere, is the three-tiered settlement hierarchy, drawn largely from Mesopotamian models in the absence of a comparable model for the sedentary sites of

Central Asia. In the dry-farming zones of the northern Jazeira, for example, this hierarchy takes the form of an evenly distributed, three-layered settlement system centred on the large, site of Hawa (nearly 100ha). Second tier sites, usually over 10 ha, occur at fairly regular intervals of 9-12 km, while the smallest sites, usually less than 5ha, may occur around 5km from the second-tier sites (Wilkinson 2000; Wilkinson and Tucker 1995). A similar interpretation of the settlement pattern has been applied to the foothill settlements in the Kopet Dag. Here, Dolukhanov suggests that the largest sites, each corresponding to a particular oasis, were separated by an average of 55km, with second and third tier sites occurring in each micro-oasis. He attributes the persistence of this pattern in part to an efficient and stable agricultural regime, and suggests that a similar organisational pattern may exist in the Murghab, based on the primacy of Gonur and distributed smaller settlements (Dolukhanov 1981).

Neither of these models, however, provides a direct parallel to the situation in the Murghab. While the Tedjen delta may offer the closest geomorphological parallel, settlement in that region is thought to have ceased by the Late Chalcolithic period, with the possible exception of Chhong Depe (Hiebert 2002). Although Lyapin (1991) has suggested that Bronze Age settlement may have existed further north, this assumption remains speculative. The known Bronze Age occupations occur instead along the foothill streams, a wetter climate where the presence of einkorn wheat and salt-adapted weeds suggest that limited dry-farming may have been practised in addition to irrigation agriculture (Hiebert 2002). A closer comparison for arid alluvial environments may be found in southern Mesopotamia, where settlement structure has been much more extensively researched. With respect to hierarchical structures in this region, Adams cautions that assumptions of regularity intrinsically associated with settlement hierarchies may not be applicable to the vagaries of alluvial settlement. Citing, for example, a major gap in occupation between the cities of Nippur, Isin and Shuruppak not well explained by geomorphology, he suggests that local variability in the settlement distribution may reflect broader strategies of land and water management (Adams 1981: 21).

In the Murghab, the ascription of hierarchy to the proto-urban settlement pattern has been drawn largely from the perception of Gonur as a large central capital (Figure 100), and even the most conservative estimates of Gonur's size far surpass estimates of other individual sites in the delta. Functionally, however, the actual nature of Gonur's influence over other delta settlements remains unknown. At first glance, it is not difficult to envision the fortified Murghab settlements as small-scale emulations of the primary site, but there are several indications that the actual situation is far more complicated. One of these is the location of Gonur itself.

Although the site is treated as central, it is actually one of the easternmost of the Murghab settlements, and the density of substantial sites (over 2 ha) beyond the main site is actually significantly lower than in more central regions of the delta (Figure 101), although Sarianidi has documented a total of 14 sites in the Gonur 'complex' (Sarianidi 1990: 34). It could be argued, however, that low densities of occupation in the surrounding area may actually strengthen the argument for Gonur's primacy, and such a possibility finds support elsewhere. For example, the beginning of the urbanising phase of Altyn Depe towards the end of the Namazga III period was broadly contemporaneous with the abandonment of the smaller site of Ilgynly Depe, possibly representing the absorption of its inhabitants into a growing urban centre (Masson 1988:14). Much further west, late 3rd millennium North Mesopotamian sites in the process of urbanisation may have expanded at the expense of surrounding towns, as evidenced by settlement pattern changes in the Khabur valley and North Jazeira (Wilkinson 1994: 490; Wilkinson and Tucker 1995). Unfortunately, a thorough investigation of the hinterland of Gonur Depe has not been conducted, so it is not yet possible to examine such processes further. Moreover, Sarianidi has linked the surrounding settlements in the vicinity of Gonur with the Late Bronze Age (Sarianidi 1990), although further research has not confirmed this chronology. If this dating is correct, however, the contemporaneity of these sites with the establishment of the smaller southern mound of Gonur may be indicative of Late Bronze processes of de-urbanisation, reflecting in the settlement pattern populations that had previously been incorporated in the larger Gonur settlement (Salvatori 2008b). However, the chronological scheme in the region is questionable, and it is highly unlikely that the Gonur North mound represents the extent of Middle Bronze settlement in that region, given the well-documented existence of mixed Middle and Late Bronze occupations throughout the delta discussed in Chapter 2.

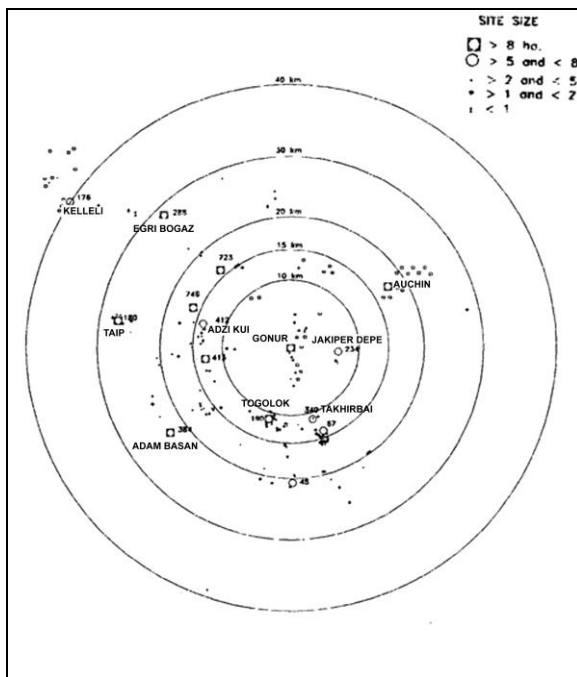


Figure 100. Estimated site distances from Gonur (Salvatori 1998b: 63, Figure 6)

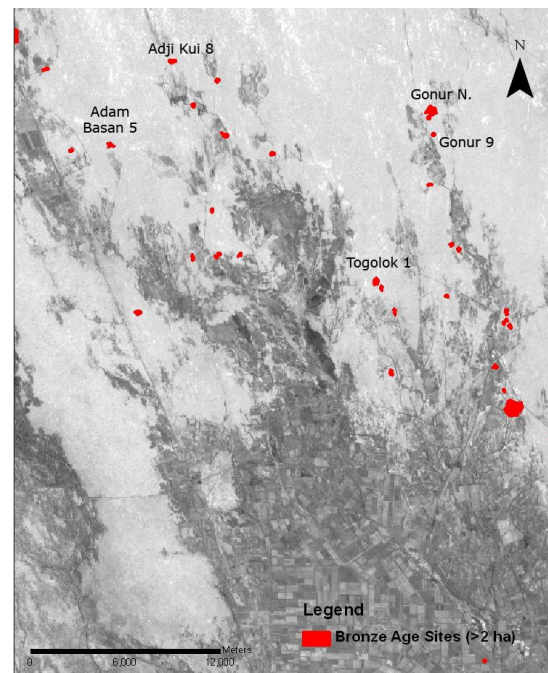


Figure 101. Settlement Density in the central delta

Another difficulty, briefly addressed at the beginning of this thesis, is that archaeologists tend to apply the BMAC label to the entire Murghab phenomenon, signified primarily in the complexity of Gonur. However, there are problems with this direct association. One problem is that the apparent standardisation of architecture that typifies the BMAC, perhaps most elegantly manifested in the ‘temple’ of Togolok 21 (Sarianidi 1994), is a Late Bronze rather than a Middle Bronze development (Figure 102). This stylistic standard, evident in Togolok 1, Gonur South, and as far as Tillya-Depe in Bactria, appears in conjunction with the decline of Gonur North, a disconnect that calls into question the influence of Gonur North on these sites. Indeed, this expansion of architectural standardisation during the Late Bronze Age, a period that Salvatori associates with a phase of decreasing site size and a shift to a post-urban developmental phase (Salvatori 2008b), suggest that a Gonur-centred hierarchical model during the Middle Bronze Age may be overstated. Nonetheless, in terms of sheer population size, scope of architecture, and quality of craftsmanship, Gonur clearly commanded a significant influence of which examples may be seen in the enormous kiln in the Gonur North palace (Sarianidi 2002a) and the craftsmanship of many of the grave goods in the necropolis (Rossi-Osmida 2002a), and it is reasonable to suggest that such a complex site may well have been largely responsible for activities whose scope lay far beyond the immediate delta region.

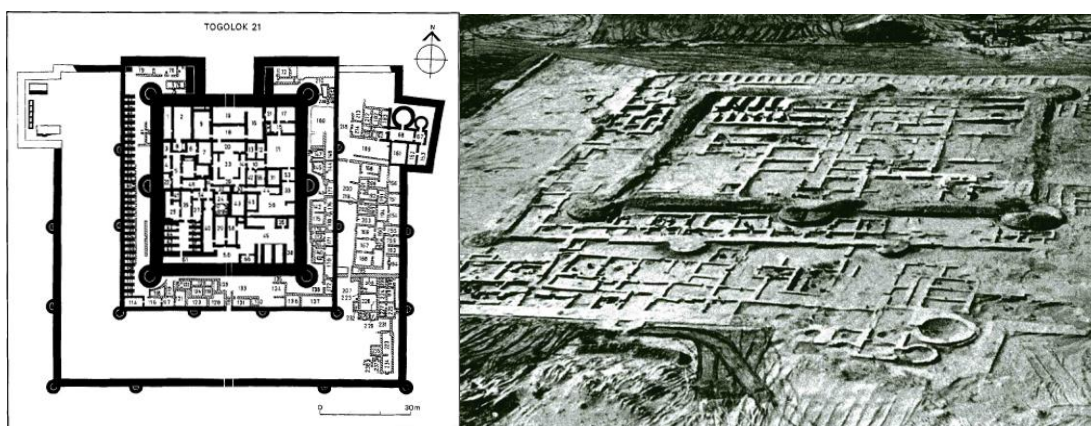


Figure 102. Togolok 21. *Left:* Plan of Togolok 21 citadel (Sarianidi 1994: 393, Figure 4) *Right:* Photo of Togolok 21 by V. Sarianidi (in Hiebert 1994: 21)

Other models, not well-explored in Murghab research, downplay this hierarchical aspect of settlement orientation at a state level, and focus more heavily on modularity at local and regional levels. One well-known model is the peer-polity settlement structure (Cherry 1986; Renfrew 1986). Originally applied to settlement entities in the Aegean, the peer-polity model presupposes the existence of a number of small, socio-economically comparable entities over a given area. Rather than existing in chance isolation, these are treated as interdependent entities, where some mechanism exists by which goods and materials may be transferred. One example of such a model in an alluvial environment may be seen during the height of Early Bronze Age occupation in the Bekaa valley, Lebanon (Marfoe 1979). Although the geomorphology of the Bekaa is very different from that of the Murghab, some useful parallels may be drawn. Marfoe envisions a localised settlement hierarchy, where primary sites of over 4 ha occur at regular intervals along the main valley corridor, surrounded by smaller settlements. He suggests that each of these modular units was broadly equivalent in its degree of influence, reflecting a quasi-linear arrangement of independent community aggregations along the valley. Lamberg-Karlovsky (1994), to some extent, has addressed the concept of modularity in the Murghab, although his interpretations fall within the oasis-based interpretation of the settlement structure. He sees a four-tiered model of kin-based organisation, drawn from current and historic Central Asian tribal structures, to explain the process of state-formation in the Bronze Age Murghab. In his view, each local group of settlements may represent a patrilineage, a kin-based aggregation of smaller tribes, all of which may have been grouped into a proto-khanate centred at Gonur (Lamberg-Karlovsky 1994). To support his assertion, he relies in part on parallels between the Bronze Age citadels and the qalas—or fortresses—that appeared in later periods, a trend well-

represented through the fortified square citadels during the Yaz III periods and later (also see architecture discussion in Mamedov 2003).

While the NMDS data alone cannot provide a definitive picture of the proto-urban structure in the Murghab, the anisotropic patterning discussed earlier offers some clues. Clearly, the orientation of channels was a major factor in the distribution of medium to large settlements, and if the western portion of the survey area is any indication, there was a degree of modularity that was at least partially related to the structure of the fluvial system. Lamberg-Karlovsky, in further developing his notion of pre-Khanate tribal structures, envisions a scenario in which the leaders of local kin-groups were responsible for managing local public-works projects, particularly irrigation (Lamberg-Karlovsky 1994). In proposing this model, he follows other researchers who have questioned Wittfogel's assumption that substantial irrigation projects necessarily require a strong central authority (Farrington 1980). It may be that, at least along individual channel networks, the settlement pattern reflects a level of community or kin-based modularity. The extent to which these groups looked to the Egri Bogaz 4 region for administration is a question that must remain unsolved, and the failure to detect any monumental structures in Area 1 certainly does not mean that they did not exist, nor does it discount the possibility that Egri Bogaz maintained a level of administrative control over the immediate region. There are, however, indications that suggest that the interpretation of Egri Bogaz 4 as one of a group of distributed secondary centres may not be the best interpretation of either this settlement or others in the delta. In both Margiana and Bactria, planned, monumental buildings sometimes occur not singly, but in pairs separated by short distances, usually within 2 or 3 km and sometimes less. The examples of Adjı Kui 1 and 9 as well as Kelleli 3 and 4 have already been cited, and to these must be added Togolok 1 and 21, as well as the T-shaped 'palace' and round 'temple' of the Bactrian site of Dashly 1 (Sarianidi 1977: 31). Although Sarianidi draws a distinction between citadel and temple (Sarianidi 1994), and Lamberg-Karlovsky, in an innovative turn, has suggested a conceptual replacement of 'citadel' with 'marketplace' and 'temple' with 'caravanserai', sufficient evidence to determine the function of these buildings remains lacking (Lamberg-Karlovsky *et al.* 1988: 20). This organisation may indicate that, partly in line with Lamberg-Karlovsky's reasoning, modularity may exist on more than one scale, reflecting aggregations of groups at various levels.

7.7 River Systems and Land Use in the Northern Murghab

Given the arid environment in the delta, an informed assessment of the nature of settlement requires an understanding of its relationship to available water resources. Although a clear picture of the hydrological network in the north is not yet available, a few investigations have been conducted, although these have not incorporated significant field research (see section 2.4). The most recently published hydrological model, generated as part of the AMMD research, refers to an ‘Adji-Kui-Egri Bogaz drainage directrix’ (Cerasetti *et al.* 2008b: 33, Figure 2.3). While this system is largely schematic, its orientation broadly follows Kohl in proposing a channel system that flows north via Adji Kui and continues just to the west of Egri Bogaz 4 (see map in section 1.3). A much more detailed system of possible channels exists for the north (Figure 103), although these remain unpublished. Furthermore, these were not subject to the same rigorous field research as elsewhere in the delta, and significant discrepancies between these channels and the satellite imagery suggest that they are much less reliable.

Figure removed pending formal publication of channel data

Figure 103. Proposed channel systems in the northern Murghab (from unpublished GIS data by M. Cremaschi)

The results of the NMDS research suggest that, even as schematic representations of streams in the northern Murghab, the current interpretations are problematic. Rather than a single fluvial system joining the Adji Kui sites in the central delta with Egri Bogaz in the north, the hydrology appears to be far more complex. Over the entire survey area, at least two distinct areas of fluvial

activity, separated by several kilometres, may be inferred from the takyr system, and each of these itself may have comprised a complex system of channels. The first of these extends NNW through the immediate Egri Bogaz 4 settlement region. A second system extends broadly northward and is related to the takyr system that dominates Area 4 and portions of Area 5. Between these, the large, cultivated takyrs likely indicate a third system. To a degree, the unpublished palaeochannel map described above distinguishes between systems in the western and eastern portion of the survey area, but again there were major inconsistencies between this data and the imagery. The following sections will address the implications of possible channel systems in Areas 1 and 4 as they relate to human settlement in the region.

7.7.1 Watercourses and Occupation in the Egri Bogaz 4 Region

The actual watercourses that sustained communities in Area 1 are difficult to interpret based on visual observation alone, and the complexity of the fluvial system in this region cannot be underestimated. Based on an assessment of aerial photography in the immediate vicinity of Egri Bogaz 4, Cremaschi has identified numerous indications of fluvial morphology (Figure 104), and similar signatures were identifiable both east and west of the main settlement area. This complexity is not depicted in the existing hydrological maps, however. Because of this lack of solid data, it is difficult to determine definitively the location of the primary channel for these settlements, although the fluvial signatures offer some clues. One candidate for a main watercourse is a long, linear takyr about 250m west of the main occupation area, running SSE to NNW and flanked by low ridges. Whether the feature is natural or anthropogenic could not be determined, and Adams (1981: 19) has suggested that natural deflation and changes in the channel flow often blur this distinction. The sherd density in this region was strikingly low given the generally high visibility in the area, and merits some discussion. One possible explanation for the lack of material may be its displacement by fluvial processes in antiquity, when the channels were still active. Several scholars have discussed the significant role of fluvial erosion in the destruction of archaeological sites (e.g. Peltenburg 2007; Brown 1997: 279), and such processes may have occurred in antiquity, ultimately contributing to the erosion of settlement mounds and the displacement of material.

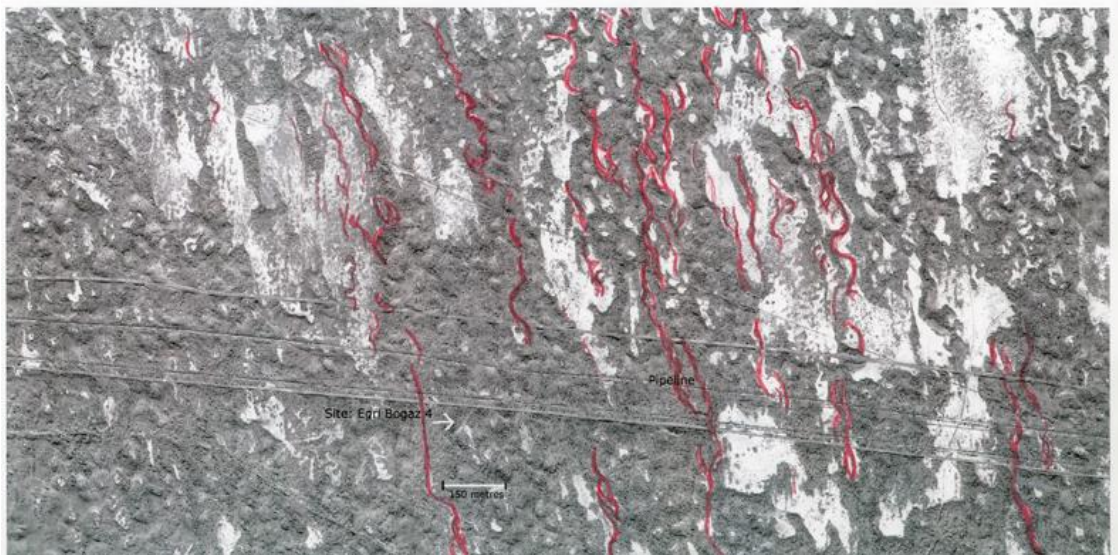


Figure 104. Main Fluvial Features in Egri Bogaz 4 Region (identified by M. Cremaschi upon request of author)

A second explanation for this apparent gap in occupation may relate to land-clearance activities in antiquity. Moore (1994) has suggested that, in order to prepare deltaic lands for agriculture and canal construction, it may have been necessary to clear significant swathes of tugai forest along the river channels. She describes an interaction between communities and their tugai micro-environments where these woodlands provided an ample supply of fuel as well as an ecosystem for game. Moore further posits that in some instances, land-clearance activities may have been curtailed in order to preserve these fragile and localised tugai ecosystems, which afforded opportunities for economic diversity and adaptation in this marginal region. It is impossible to determine with certainty the extent of this woodland in antiquity—estimates of tugai breadth along primary river systems range from a few hundred to a few thousand metres along the major rivers in Turkmenistan as well as the Amu Darya, although deeper tugai forests have been documented elsewhere (Thevs 2007; Ruger *et al.* 2005). Towards the margin of the delta, several factors suggest that tugai vegetation may have been more intermittent. The woodland is a fragile ecosystem, heavily reliant both on floodwater and the presence of a high water table. Moreover, high soil salinity, which occurs naturally in the region even without irrigation, impedes forest growth. Although interfluvial zones may offer a moderate potential for tugai growth (Ruger *et al.* 2005), the increasing lack of water towards the delta fringe, both in channels and subsurface, suggest that the tugai vegetation would have been more sporadic in this region than in the main delta fan.

A hypothetical land-clearance zone in the area of primary occupation is shown in Figure 105. The possible tugai region in this area covers several dozen hectares, an area large enough for some agriculture to have been practiced but too small to support a significant population (see section 7.7.4). Broader cultivation areas may have been available in the sparsely populated, yet apparently well-watered, area east of Egri Bogaz 4. Unfortunately, evidence of small transverse canals could not be identified in the survey area, and it is quite possible that a network of small canals existed not only in association with the main watercourse of Egri Bogaz 4, but also with other, smaller channel systems beyond the site itself. Adams (1981) has described the potential advantages of multiple water sources from the perspective of agriculture and settlement growth, and such may be the case in the northern Murghab as well.

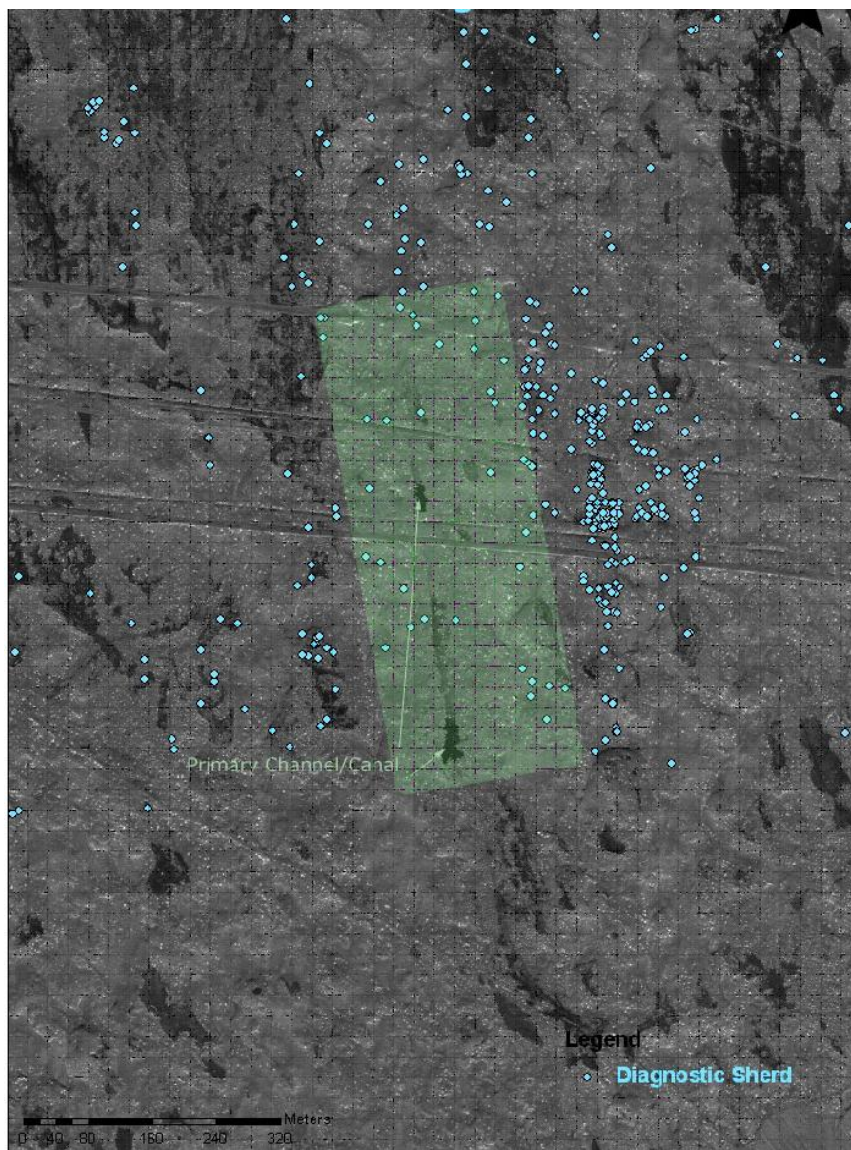


Figure 105. Schematic Diagram of Possible Land Clearance Area

7.7.2. Watercourses and Occupation in the Western Survey Area

In the western portion of the survey area, there is evidence of a secondary fluvial system entirely unrelated to that in Area 1. Two possible palaeochannels, identifiable in the satellite imagery, support this assumption. The first is a long, meandering feature that extends from southwest to northeast and skirts the Area 4 takyr to the east (Figure 106). The trajectory of this feature was difficult to trace in the visible imagery, and multispectral image enhancement was found to be useful in its identification. Although more geomorphological work clearly needs to be conducted, the imagery indicates that this possible channel may be associated in part with the Taip settlement group, although the region immediately northeast of Taip has not been heavily surveyed, so little can be definitively stated about occupation in this area. There are some observations worth noting, however. Four Bronze Age diagnostics were found at the western edge of the survey area, all within 150m of the channel. These were fairly isolated, located over a half-kilometre from the heavier concentrations in the region (notably L42), and therefore do not appear to be directly associated with more significant occupational areas. The second possible system extends from south to north, skirting the large takyr in Area 4 to the east, and is likely associated with more significant occupations in L42 and D70. While the general trajectory of this system may be inferred from the remote sensing data in places, it is not possible to determine with certainty the hydrology of particular channels without further research. However, indirect evidence of its continuation may be seen in the long chain of sites directly east of Adam Basan 5 which broadly follow a similar trajectory (refer to section 7.3, figure 97). The evidence may thus indicate a single fluvial system that flowed northwards from the central delta, of which the sites in the western portion of the survey area represent the northern extent.

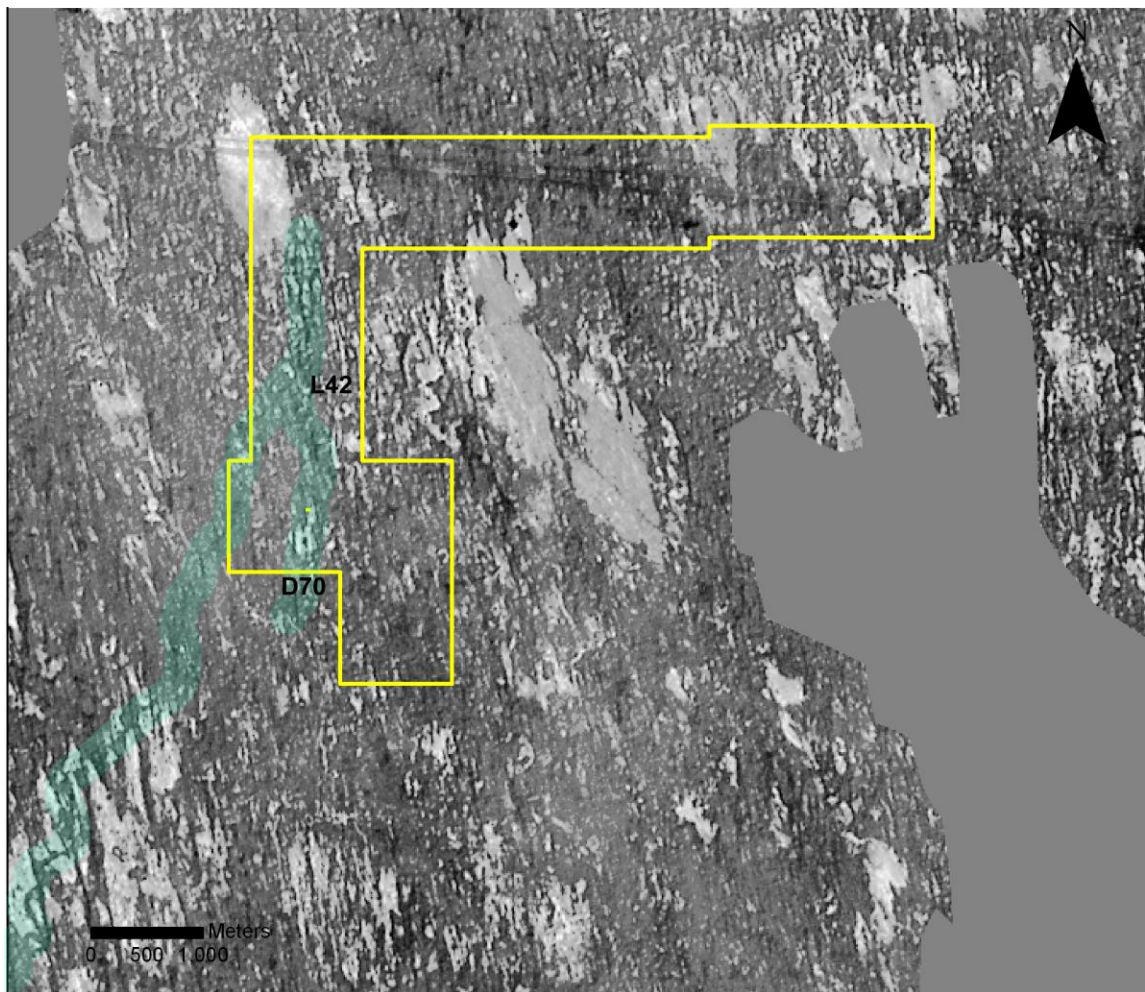


Figure 106: Proposed channel systems in the Western Survey Area (ASTER PCA image) Channels are indicated by winding grey tracks in the image and have been highlighted in blue. The eastern system likely continues to the south, but is difficult to trace in the imagery.

If the hypothesis that both features were active Bronze Age watercourses is accurate, the occurrence of a major surface scatter at their confluence is interesting in light of Bader's observation that Murghab settlement often occurs at points where channels bifurcate (Bader *et al.* 1996). He attributes this in part to a kind of cultural memory of similar irrigation practices in the Kopet Dag, and one possible conclusion may be that the access to a more substantial water source was recognised as a boon to sustained agricultural development. Moreover, the access to secondary channels may have significantly increased the area available for agriculture, no longer restricted to a single channel. The ability to easily move between field and settlement spatially, and not just along the channels, may have therefore broadened the agricultural area while decreasing its linear extent, ultimately increasing accessibility and facilitating agricultural development and population growth. Although the proposed fluvial system here appears to be a confluence rather than a bifurcation of channels, the increased access to multiple water sources

may have held a similar attraction as a new settlement location. Even if this is the case, it does not directly account for the occupations north or south of this confluence, and it is likely that individual streams were sufficient for small, local agricultural communities to develop. Unfortunately, it is not currently possible to obtain a fine chronology for settlement in this region and both Middle and Late Bronze material occurred together. Consequently, it cannot be said definitively whether these sites were fully contemporary, or whether, perhaps, there was a shift upstream as the availability of water and fertile land decreased with accelerating processes of desertification.

The picture that therefore begins to emerge for the western portion of the survey area is one of small-scale but persistent occupation situated in close proximity to watercourses. The largest of these were separated by approximately 1 km, with smaller communities intermittently distributed. The small size of these communities and their distribution along the channel networks suggests a degree of self-sufficiency at the local level, in which small communities, rather than a larger regional centre, were responsible for their own activities with respect to land-clearance, small-scale irrigation and farming. Clearly, a kilometre is not a significant distance to travel between communities, so such projects would have been conducted within a broader cultural milieu. The question of whether each settlement represented a kin-based community, or whether settlements were linked via other cultural phenomenon, cannot be adequately assessed at present, and the nature of the influence held by the larger communities in Area 1 over these small settlements remains an outstanding question.

7.7.3 Water Accessibility

The above discussion highlights the importance of water in relation to settlement, and although neither occupation nor watercourses can be precisely delimited from the surface survey, some tentative conclusions may be drawn concerning the nature of occupation in the region. In Area 1, the main area of occupation was likely situated a few hundred metres away from the channel system. Such a model finds support elsewhere in the delta where the main occupied regions of major sites such as Gonur and Togolok 1 were situated a few hundred metres from their respective channels (AMMD GIS system). Moore (1994) notes that sites may occur on naturally elevated areas which offered a protected environment, safe from spring flooding, around which agricultural fields would have been situated, and several sites in the Murghab occur on natural rises. While flooding in this distal region of the delta may have been less predictable than in the

central delta,¹³ the awareness of flood potential may have warranted a careful balance between accessibility to water sources and caution. It is difficult, however, to determine whether similar factors applied in the study area. As discussed in section 4.5, analysis of the remote sensing imagery did not detect significant variation in fluvial topography in the northern delta, and the shallow stratigraphy of northern sites offers little evidence of clear topographical preference in settlement location, and elevated regions may be entirely anthropogenic in nature. At the same time, however, evidence from both Areas 1 and 4 indicates a weak but discernible relationship between more significant surface scatters and dune ridges, and it is possible that this situation reflects a chain of occupation in areas of slight topographic prominence, perhaps on natural levees that over time have developed into dune ridges (cf Lioubimitseva 2003).

While conclusions regarding water and settlement are only tentative, the preceding analysis suggests that at least some of the moderate scatters along this corridor pertain to small settlements and cannot be written off solely as the result of post-depositional processes. If this is the case, a possible relationship may be drawn between site size and proximity to channels. Small occupations both in Area 1 and in the western part of the survey area may have been located closer to watercourses, with larger settlements established slightly further away. While speculative, such a settlement pattern may reflect the reduced capacity of smaller communities to undertake agricultural projects on the scale of their larger counterparts. Another possibility is that, over several centuries, settlement structures evolved organically, influenced by changing watercourses and perhaps related shifts in zones of highest agricultural potential (also see below).

Clearly, the fluvial system was integral to the settlement distribution, a situation that calls to mind Adams' research in southern Mesopotamia, although on a much smaller scale. He describes the settlement patterns of the lower Euphrates as a series of 'ribbons' of occupation along the channels, and partially attributes the resulting spatial irregularity to the demands of a centralised authority in both administration and extraction of wealth and surplus that may have been facilitated by the navigability of the channel system (Adams 1981: 21). Wilkinson (2000) has also addressed the offsite regions between the irrigated zones, positing that settlement voids during the Uruk and later periods may represent regions where irrigable land was less accessible, resulting in less cultivable land and a consequent dearth of occupation. He qualifies this possibility, however, by suggesting that gaps in settlement may also have resulted from

¹³ See McCarthy (2003) for related discussion of inland delta flooding of the Okavungo Delta, Botswana.

significant alluvial deposition, and both scholars recognise that the lower Mesopotamian settlement pattern is far from complete. The Murghab distribution therefore exhibits some of the hallmarks of the southern Mesopotamian settlement distribution, although the scale of the entire system is much smaller. Settlement sizes and consequent populations are lower in the Murghab delta, and there is no evidence that Adams' proposed level of state development and administration for Mesopotamia was matched here. Channels in the northern Murghab, as in Mesopotamia, likely acted as conduits not only for agriculture but for communication and perhaps local administration.

7.7.4 Population and Land Use in the Study Area

While some general insights into the relationship between land, water and settlement are possible, it is difficult to provide a clearer picture without understanding the nature of the communities themselves. Unfortunately, many facets of actual occupation are not detectable through surface survey. Two potentially measurable aspects, however, are settlement size and population, although these metrics are difficult to estimate effectively, particularly in the Murghab. While the problems with site size have been discussed throughout the thesis, the population issue warrants some additional discussion. As noted by Alcock and others, population estimates based on surface scatter alone are notoriously unreliable (Alcock *et al.* 2000; Wilkinson 2003b), and the NMDS survey data offers nothing in the way of discrete architecture, measurable hinterlands, or even reliable estimates of settlement size from which to begin an analysis. Nevertheless, there are methods through which relative population estimates may be explored to examine possible ranges of occupation and to ultimately to derive a better understanding of the ways in which people and resources may have been distributed (Wilkinson 2003b).

Population estimates for settled areas in both dry-farming and irrigated zones throughout the Near East commonly range from 100-200 persons per hectare (Kramer 1982; Stein and Wattenmaker 1990), although Stein and Wattenmaker suggest that urban densities may actually be significantly lower than those of outlying villages due to the large proportion of public space that may not have been available for domestic occupation. Furthermore, Kramer observes that the degree of nucleation or dispersal within even a single community can heavily influence the on-site population density. She cites significant population variability in settlements in parts of modern-day Jordan and Khuzestan where densities may range from 20 persons/ha in dispersed

settlements to 200 persons/ha in villages (Kramer 1982: 159, Table 5-2). While a significant degree of variation must be considered, population estimates can, however, offer useful perspective regarding the agricultural capacity for these settlements.

Because of the extreme difficulty in determining the actual occupied area of NMDS settlements, an estimate of population is perhaps even more confounding than usual. However, the apparent dispersal of inhabited space and consistently shallow cultural levels suggest that the highest population estimates are likely unwarranted. Moreover, the marginal climate of the entire delta, the relatively brief period of occupation, and perhaps a reduced productive capacity in the deltaic fringe all suggest that populations may have been even more restricted, particularly in the north. It is difficult, however, to determine where a population estimate might start. The extent of surface material associated with the Area 1 settlements approaches 100 ha, of which 60 ha or so contained moderate to high densities of material. The lack of significant subsurface cultural deposits, however, suggests that most of this material, especially in the low lying takyr, resulted from erosion. Significant populations were most likely concentrated on a number of small, low mounds, some of which are partially or wholly obstructed. Since these are often indistinguishable from dunes, they cannot be easily traced, but it is unlikely that actual occupied area in this central region exceeded several hectares. An estimate as high as 10 ha, for example, significantly larger than the estimates for nearly all Murghab sites, would yield a total on-site population of about 1,000 persons in the main settlement area (assuming the lower end of the range), and quite possibly far fewer. Immediately to the west, the partially continuous line of occupation was most likely comprised of small individual settlements or areas of related activity. Even if several of these occupied regions comprised up to two hectares, it is a stretch to envision a maximum population of more than around 1,500 persons for the primary settled portions of Area 1 and outlying occupational areas, although the extreme complexity of the surface scatter renders any population estimate purely a conceptual starting point, rather than a definitive estimate. While Areas 1E and 2 both exhibited evidence of small-scale occupation, the general absence of architectural debris and the sparsely distributed, generally non-diagnostic material point to scattered outlying occupations or intermittent pastoral or agricultural activity (see section 7.4.1), some of which may have occurred within the hinterland of the Area 1 settlements. A few kilometres to the west, the overall extent of material scatter in Area 4 covers approximately 10 ha. The actual extent of primary occupation may have been small, however, and clearly not conterminous with the sherd distribution on the takyr surface. While much of the surface material consisted of small, heavily abraded sherds, evidence of some brick debris in the southern part of this takyr may broaden the scope of occupation to include very small peripheral

settlements. As noted above, it is unlikely that most of these occupations spanned more than a hectare or so, and the fairly even, if intermittent, distribution of these communities along the channels, together with smaller outlying occupations, suggests that populations were unlikely to have exceeded a few hundred persons over several kilometres.

To place this small portion of the northern Murghab in perspective, some population estimates may be derived from architectural remains elsewhere in the delta. Several methods have been employed to attempt to estimate populations based on domestic living space (Casselberry 1974; Naroll 1962), and some comparative population estimates for the confirmed built environments of known Murghab sites are shown in Table 21. For the typical walled ‘citadel’ (with the exception of Gonur North), the maximum population was likely no more than several hundred, possibly as high as 1,000, although these numbers do not consider settlement beyond the known built environment. Evidence from several sites (e.g. Kelleli 3, Gonur 1, Adjı Kui 9), indicates the presence of additional domestic architecture beyond the fortified centres (Salvatori 2002; Masimov 1980; Hiebert 1994a), although these outlying areas may have been less densely populated (Kramer 1982). The outlying case of Gonur Depe, both in terms of estimates based on site size and architectural area, suggests a much higher population on the order of several thousand, a number that is substantiated by the excavation of thousands of burials in the Namazga V cemetery (Rossi-Osmida 2002b). In addition to the population of Gonur North, the recovery of over a dozen sites in the vicinity of Gonur (Sarianidi 1990) suggest that regional occupation may have been significantly higher, although not all of these settlements were necessarily occupied at the same time.

Table 21. Population Estimates for Various Murghab Sites based on architectural evidence

Site	Pop. Range (main structure)*
Kelleli 3	1000-1080
Kelleli 4	90-101
Gonur N.	2100-2265
Adjı Kui 9	490-535
Togolok 21	1,000-1080*

*Low population estimate uses Naroll’s estimate of 10 m² of living space per person. The higher estimate reflects Casselberry’s calculation of 6 persons for the first 25 ft², then 100 ft² of living space for each additional person.

A significant body of research has explored the relationship between population and sustaining areas necessary to support settlement (Stein and Wattenmaker 1990). Although analysis based solely on such nebulous population estimates is difficult—and perhaps risky from an interpretative perspective—a cautious examination can offer insight into land use strategies and ultimately broader socio-economic practices. Near Eastern archaeologists have proposed anywhere from 1 to 3 ha of cultivable land per inhabitant, with the more marginal dry-farming zones in northern Mesopotamia falling in the higher range due to a decreased productive capacity and reliability (Stein and Wattenmaker 1990; Wilkinson *et al.* 2007). Assuming a conservative size range of 5-8 ha for densely settled zone in Area 1 and 1.5 ha per person, this would result in a circular zone of cultivation with a radius between 1.2 and 2.2 km. There is no reason, however, to assume that sustaining areas along a channel would have been equal in all directions (Adams 1981; Peltenburg 2007). A better representation may be a linear or more elliptical hinterland, or, given the probable complexity of the channel network, perhaps a highly irregular and organic form. It is not possible to determine precisely the location of preferred agricultural land based solely on surface scatters, however. The direction of fall-off in material away from the main scatters, broadly perpendicular to the fluvial signatures, may indicate hinterlands irrigated either from canal systems associated with primary watercourses, or from more localised natural or modified watercourses east of the settlement. While there is no way of knowing the extent to which cultivable land may have extended beyond the stream channels in the northern delta, the lack of obvious large scale canalisation suggests that fields may have been directly irrigated by the palaeochannels, perhaps subject to anthropogenic modification or the construction of small supplementary canals. Water may have been carried to the fields by networks of small feeder canals, a possibility that concurs with Bader's depiction of the irrigation systems during the Bronze Age (Bader *et al.* 1996).

7.8. The Northern Murghab as Marginal Settlement Environment

A substantial body of recent research has focused on the adaptive strategies employed by communities living in marginal, dryland environments (Wilkinson *et al.* 2004; Barker and Gilbertson 2000). The concept of margin, defined in this context, may be envisioned as a zone of relative adversity with respect to precipitation and, consequently, agricultural potential. Many recent studies have focused on the resilience of agricultural communities in the face of deteriorating conditions (Barker and Gilbertson 2000). One recently discovered example may be

seen in the well-planned, agricultural site of al-Rawda in western Syria. The presence of this site in a stark, arid environment represents an anomalous flourishing of urban planning and agricultural production during the last quarter of the 3rd millennium, a period and region usually associated with urban decline and a concurrent transition to a more pastoral economy (Castel 2007). A related development may be evident in the Homs region, where the stability of the settlement pattern during the EB IV period suggests that settlement may have intensified, rather than declined, during the period (Philip 2010). Philip attributes this development largely to a growing awareness of and adaptability to the more marginal steppe environment to the east.

While strategies in marginal environments may be both adaptive and innovative, It is often all too easy to infer simple causative relationships between environmental change and human adaptation (Rosen 2007: 1-3). It is not necessary to revisit the well-known controversies surrounding environmental determinism, but it is important to be aware of the distorted vision of hindsight. Brown cautions that what we may interpret as innovative strategies of adaptation may not have been construed as such by those who developed them (Brown 1997: 279). In many cases, to be sure, strategic decisions at both local and administrative levels anticipated and dealt with major events, including not only immediate events such as floods, but also longer term changes to the fluvial system. Texts from early second millennium Isin and Larsa, for example, demonstrate both administrative awareness and directives in response to water management, although local officials rather than the state may have been responsible for the direct implementation of such policies (Rowton 1967). More subtle environmental or geomorphological changes, however, such as deforestation, salinisation (Adams 1981) or productivity loss in soils, were likely less detectable, and when a tipping point may have been reached, it is likely that adaptive strategies—whether these included physical movement, changes in water management, or agro-economic strategies, were often slow to develop.

The myriad small settlements and channel systems distributed over a small region of the northern Murghab suggests that its occupational history, although comparatively short-lived, was complex. As discussed in Chapter 5, there is a strong case to be made for relatively widespread Middle Bronze Age occupation and directly related activity such as agricultural processing, livestock management and small-scale crafting within the bounds of the survey area, and based on the subtle yet perceptible shift in the distribution of identifiable Middle and Late Bronze materials in Area 1 (see Chapter 5), there are signs that the more restricted Late Bronze occupations that Salvatori (2008b) observes elsewhere in the delta may have occurred here as well. The abandonment of the region into the Iron Age, while perhaps not total, is strongly

supported by the survey data, and clearly aligns with other findings in the delta. Although the specific chronologies cannot easily be fine-tuned without further research and excavation, there is enough of a diachronic trend from the survey data to be able to propose some theories linking settlement change with geomorphological change in the region. As noted in Chapter 4, the SRTM imagery suggests that the clear topographic signature of the palaeodelta apparent in the Merv oasis are no longer easily traceable this far to the north, although an exception may be found in the westernmost channel system connecting Taip with the Kelleli sites. The tenuous yet identifiable association between these natural levees and the known palaeochannels in the central delta suggests that the topography towards the distal portion of the delta, beginning in a region approximately north of the Adji Kui region, is much gentler than further to the south. While this gradual flattening of the topography may be expected towards the fringe of the delta fan, it may offer some different perspectives on the nature of settlement in this particular region.

In order to better understand the settlement characteristics in this distal portion of the Murghab delta, it is useful to briefly examine possible behaviours of the river system that may have influenced the distribution of settlement. Marangenli (2004) has described two general fluvial types that occur in arid and semi-arid zones. The first of these are perennial streams, often on the order of a few dozen to a few hundred kilometres in length. These regimes are often characterised by sporadic yet intensive flood cycles. While the stream channels of these systems may initially be well-defined, channel definition decreases towards the fringes of the delta fans. Eventually, individual watercourses effectively become undetectable, opening into a landscape of mud flats often typified by sebkha (takyr) environments. At the other end of the spectrum are extensive, typically rain-fed, exotic rivers, often on the order of hundreds or thousands of kilometres in length. These tend to lose water along their course, and may weaken enough to form inland deltas characterised by braided stream channels. The endorheic deltas of the Murghab and Tedjen are perhaps anomalous in that they exhibit characteristics of both classes, although the dendritic patterns of their respective deltas tends to resemble the former perennial streams. A comparable fluvial regime may be found in the Okavungo River in Botswana, where water loss results in a dendritic fan in the sands of the Kalahari, irrigating an extensive 15,000 km² (Stanistreet 1993; McCarthy 2003).

In such an environment, it may be that while channel accessibility largely determined the possibility of settlement, there may have been other options as well. Sherratt (1980) has suggested that as early as the late Neolithic, small transverse canals were constructed off of braided streams in Choga Mama, as well as in several Kopet Dag sites. He further notes that in

some cases, the sheet flow associated with shallow canals may have been enough to facilitate non-canalized small-scale irrigation. Moreover, small pockets of more fertile soil, even in interfluvial regions, could have been exploited by small farming groups, although these may have been less reliable. With respect to the northern Murghab, it is quite possible that several of these strategies may have been employed concurrently. The prevalence of small pockets of occupation far from major settlement areas may offer some evidence of at least a small degree of local self-sufficiency with respect to water acquisition and management. While these sites are probably best viewed as short-term occupations or activity areas due to the paucity of material and complete lack of architectural remains (see section 7.4.1), there may have been enough available water for localised subsistence agriculture. A kilometre is not any great walking distance, however, no more than 15 minutes or so, and it may be more reasonable to assume that the bulk of foodstuffs were obtained from more significant agricultural fields closer to the centre. At present, however, there is not enough information to definitively assess the degree of economic and agricultural centralisation in the region.

While speculative, we may now put forth a picture of a northern Murghab settlement environment where water sources, while perhaps plentiful and easily accessible, may have been rather unreliable even as early as the Middle Bronze Age—and increasingly so as encroaching aeolian deposits and continuing processes of aridisation and consequent water loss (see section 1.8; also Weiss 1993; Cremaschi 1998) began to interfere with the natural drainage network. The complexity of the takyr system may reflect shifting stream channels, particularly in Area 1. While such complexity may have offered some advantages in terms of access to varied water sources, it may also have been symptomatic of an increasingly unreliable hydrological system. An interesting comparison may be made with some of the wadi-based settlements in Syria and elsewhere in northern Mesopotamia. Wilkinson has noted that, in many cases, settlement tended to occur towards the termini of the wadis, where water may be more manageable and closer to the surface (Wilkinson and Tucker 1995: 29-30). Soils in these regions are often highly fertile, and in several instances initial settlement tends to occur in such areas. Over time, settlement became possible further upstream, facilitated by an increasing population and larger labour force better able to manage a potentially more productive, but complex, irrigation system. One example of this pattern may be seen in the southern portion of the Homs Survey in the Orontes Valley, Syria. In this region, survey data reveal the existence of sporadic Chalcolithic settlements (e.g. sites 251 and 478) at the downstream end of the wadis, with an increase in upstream occupation into the Middle and Late Bronze Age (e.g. site 254) before eventually shifting away from these localised water sources with the development of larger, state-

administered irrigation projects (based on GIS data from the Survey of the Homs Region evaluated by the author in 2005 in the course of MA research).

Clearly, the northern Murghab cannot be assumed to foster the same kinds of settlement patterns that would be found along wadi systems, although the arid climate in these regions would have necessitated irrigation agriculture and restricted primary settlement to regions along the channels themselves. Unfortunately, the narrow chronological window in the Murghab restricts the ability to investigate the development of settlement with respect to irrigation agriculture. However, it is a reasonable assumption that, if the Middle Bronze occupation in the Murghab originated in part from the Kopet Dag (see Section 7.10), requisite water-management and irrigation strategies would have been familiar territory. Knowledge, however, still required the necessary labour to implement it, and more research is necessary to investigate the manner in which such projects may have been structured, and the level of administration driving them.

7.9 *Survey in Context: Examining the NMDS Data in Light of Central Asian Settlement Patterns*

7.9.1. Comparative Intensity of Occupation

The results of the NMDS survey, when situated in the context of the rest of the work that has been conducted in the northern fringe of the Murghab, thus demonstrate highly complex and variable settlement patterns within what had been previously viewed as an almost empty settlement landscape. Moreover, as illustrated above, the overall orientation of settlement with respect to the fluvial system reflects a consistent character that occurs throughout the delta, although at a smaller scale both in terms of the intensity as well as the distribution of settlement. The apparent absence of large settlement mounds, supported both by the remote sensing analysis and in-field observations, suggests that these are substantially less prevalent in the region. While raised occupational areas were detectable in Area 1, their actual elevations were difficult to estimate due to the substantial sand cover, and evidence from the southern Egri Bogaz sites, as well as those in the Kelleli region, suggests that while deflation has almost certainly contributed to reducing site elevations, even fortified sites (e.g. Kelleli 3) did not attain any significant elevation even in antiquity. The shallow cultural levels of these northern sites may be compared with evidence from elsewhere in the delta in further support of a reduced occupational intensity. While the depth of cultural material in this region tends to coincide broadly with the uppermost takyr layers, recent research suggests that this is not the case everywhere in the delta.

Unpublished excavations at Adjı Kui 1, which rises approximately 3.5m above the takyr surface, have unearthed cultural layers up to 1.8m below the takyr (G. Rossi-Osmida, pers. comm.), and Hiebert notes that, while Gonur North appears to have been constructed on a raised section of the alluvial plain, the southern mound of Gonur was dug into the takyr surface (Hiebert 1994a). Conversely, the few excavated northern sites are usually shallow mounds seldom surpassing a metre or two in elevation, and significant deposits below the takyr level have not been recorded. This profile is reflected in the NMDS survey area as well. The ash deposits noted in the Area 4 test pit, for example, occurred on or slightly below the takyr surface beneath the dunes, and the possible oven in the northwest portion of Area 1 may similarly indicate a feature constructed on or just below the Bronze Age alluvial surface. While the more deeply buried cultural levels in the central delta (e.g. Adjı Kui 1, Togolok 1) may be related to heavier alluvial deposition further upstream (see section 1.9), the increased thickness of the cultural deposits towards the south and the larger number of clearly identifiable settlement areas suggests that populations there were substantially larger and the area more intensively occupied.

7.9.2. Comparative Distribution of Settlement

In order to gain some perspective on the significance of such a settlement distribution, it is useful to consider the region in light of comparative developments elsewhere, particularly in the Kopet Dag foothills. In terms of both intensity and breadth of settlement, the Murghab phenomenon represents a different occupational structure than that which occurred in southern Turkmenistan. The thickness of the Namazga V and VI levels in the Murghab, even on the largest sites, rarely surpass a metre, while cultural levels on the order of 10 or 12m occur at sites such as Altyn Depe and Ulug Depe (Masson 1981). While it is possible that deflation of the drier, sandier soils of the Murghab may have reduced the thickness of cultural levels more rapidly than in the moister soils of the foothill range (and it is worth noting that Aurel Stein (1925) suggested that deflation may have lowered the exposed desert surface by as much as a foot per century in parts of the Tarim Basin), it is likely that the thin cultural levels reflect less intensive settlement in the Murghab. However, the tenuous chronological understanding of Murghab pottery means that direct comparisons with southern Turkmen sites are difficult, so there may be chronological overlap that has not yet been clearly identified.

In addition to the intensity of occupation, the overall settlement patterns are significantly different as well. In the Murghab, occupation is broadly distributed throughout the river system

forming the broadly linear trajectories discussed in Chapter 6, and similar settlement patterns are identifiable in the Bactrian sites (Hiebert 1994a: 28) (Sarianidi 1977). Masson (1981) attributes the broader geographic scope of occupation in Bactria and Margiana to what he sees as a more highly developed irrigation system, where the linearity of settlement orientation represents a highly organised network of irrigation canals, although, as noted above, such an extensive system is disputed by Bader (1996). Similarly, Lisitsina (1981) has questioned the extent of the irrigation system in this area, and the lack of clearly identifiable canals in the survey area may indicate that irrigation in the region was actually less developed than in the Kopet Dag—perhaps the result of the focus on local water management strategies and the lack of a substantial and centrally mobilised labour force. In this context, it is worth revisiting the linear feature in Area 7, discussed in Chapter 5. While speculative, if the feature is indeed anthropogenic in nature, and if the ‘brick kiln’ was in fact used for a sluice or dam (see section 5.6.5.), it may suggest a more substantial mechanism of water control, perhaps attributable to the burgeoning administrative capacity evident in the Adji Kui region. Such a possibility is interesting in light of other linear features in the Gonur region that have been identified by Marcolongo and Mozzi (1998), and may be anthropogenic in origin, although their function has not been determined.

Given the distinctive nature of Murghab occupation, it is clear that the Murghab delta does not reflect a simple reorientation of the foothill settlement pattern, but has its own distinct character. In the foothill zone, the settlement pattern is broadly nucleated, and depes may reach 25-30m in height. The nucleation of Bronze Age sites, particularly in the Near East, has been the subject of a great deal of recent research in recent years (Wilkinson 2003a), and attributed in part to the centralised administration and systems of land-tenure that persisted through the Iron Age (Wilkinson *et al.* 2004). Similarities between many of the Kopet Dag sites and those in northern Mesopotamia and Anatolia suggest that similar processes were in evidence during the urban phase here as well. In the Murghab, some nucleation of settlement occurred, but to a very limited degree. The fortified settlements clearly indicate centralised areas of occupation, at least on a local level, and evidence of production in the survey area both in terms of the concentrations of vitrified brick as well as the evidence of metal and possible slag suggest that mechanisms of local production were in place (cf Hiebert 1994b). However, the overall trajectories of occupation were quite fluid and complex, as the complex distribution of material in the NMDS survey clearly illustrates. Primarily in Area 1, but also along the channel systems in the western part of the survey area, continuous but clustered aggregations of material offer a picture of highly dynamic local activity and interaction within the settlement pattern that is not

reflected in the large nucleated settlements in southern Turkmenistan, only a few hundred kilometres to the west.

7.9.3. Re-Examining Settlement Trends in the Murghab

Given the still-hazy picture of the development and decline of Bronze Age society in the northern Murghab, it is important to assess how the local settlement patterns of the NMDS survey fit into the broader inter-regional picture. Via its 'BMAC' guise, settlement in the Murghab is often treated as a specific development that arose out of a broadly west-to-east cultural shift. Whatever the reasons for this movement eastward, the development is described by several researchers (e.g. Hiebert 1994; Kohl 1981), in terms of colonisation from southern Turkmenistan, a response to deteriorating climatic and environmental conditions, touched upon in Chapter 2 and revisited below. Dolukhanov (1981) suggests that the shift may have resulted from population pressure resulting from intensive cultivation by communities in the Kopet Dag foothills. In this view, movement east was driven largely by the decrease in available farmland and the consequent search for untapped agricultural resources that were certainly available in the Murghab. Masson (1981) broadly agrees, tracing the eastward shift largely to deterioration in the foothill micro-environment in southern Turkmenistan, owing in part to deforestation and ultimate desiccation of the environment (see Chapter 2).

While the similarity in material culture between the Murghab and southern Turkmenistan suggests that migratory processes contributed to the late Namazga V peopling of the Murghab, it is worth exploring how such processes may have transpired, and if the NMDS data can offer some perspective. If such movement occurred on a grand scale, it is possible that the process may have been driven in part by a central authority in southern Turkmenistan, of which Altyn Depe, based on its size and its precipitous decline in the Namazga VI period, may be the most likely candidate. If this is the case, the late Namazga V period in the Kopet Dag may be seen as a kind of 'last gasp' of urbanised society in the face of an already weakening inter-regional economic system (cf Weiss 1993). It may therefore have made sense for ruling or administrative groups to look eastwards for easier access to commodities such as tin (Kaniuth 2007a), or luxury goods such as lapis lazuli. Indeed, the substantial settlement of an area largely lacking in natural resources apart from fertile land and alluvial clays may further support the possibility that settlement here offered some promise in its increased proximity to raw materials, a trajectory of movement that eventually incorporated the richer Bactrian region a short time later. It is difficult, however, to determine just how much, if any, of the initial settlement of the Murghab

delta may have been determined by direct colonial aspirations. Indeed, the Namazga VI evidence at Altyn Depe is almost absent (Masson 1988), and while some of the initial movement towards the Murghab at the apex of the urban period may have been driven by a central authority, it is doubtful that such an authority would have directly controlled the continuing settlement of the Murghab.

A more likely possibility, then, and one that may see some traces, albeit speculative, in the clustered continuity of the survey data, is that groups independently moved east in the face of a weakening urban centre increasingly restricted in its ability to support its inhabitants. Although tracking such movement is difficult due to the poor understanding of the region between the Murghab and Tedjen, the proliferation of small sites in the Kopet Dag foothills during the Late Bronze Age (Biscione 1977; Kohl 1981) suggests that settlement remains dynamic during the period, and Biscione cites the persistence of small sites during this period to suggest that populations remained fairly stable, if more difficult to trace. One model, then, is an uneven ripple effect from the west rather than a direct, centralised colonisation process. Anthony (1990), in discussing migratory patterns of nomadic cultures, identifies several patterns of increasing breadth and intensity by which people may move from one place to another, and although his theories are largely applied to mobile groups there is no reason to discount similar behaviours in sedentary communities. At the largest scale are significant kin-based movements, where entire groups may, either together or over long periods of time, move to regions where the perceived benefit is greater. It is likely that communities in the Kopet Dag region were aware of the agricultural potential in the Murghab delta, particularly if communities were already extant in the lower delta prior to the large-scale occupation that took place towards the end of the Namazga V period. The area between the easternmost sites of the Kopet Dag and the Murghab delta is less than 150 km, not close enough for constant transit but well within range of longer-distance exchange, and the Kopet Dag offered substantial resources (e.g. flint, turquoise; see also Coolidge 2006) to encourage continued movement to and from the Murghab even in the wake of a broader shift to the east.

Returning to the survey data, the clustered, quasi-linear patterning evident at several concurrent levels of analysis indicates substantial variability in the peopling of the delta, and suggests that small settlements likely appeared unevenly in fertile areas along river channels. Larger communities, as evidenced from the chains of high-density areas in both Areas 1 and 5, aggregated in similar fashions, their higher populations facilitated by greater access to cultivable land (see above). The similarity of the distribution of the larger aggregations in the NMDS

region to those found elsewhere in the delta suggest that such processes occurred on a fairly large scale towards the end of the Namazga V period, and the clear directionality in the orientation of these settlements, in accordance with the channels evident in the satellite imagery, demonstrates the enormous significance of the fluvial system in shaping the initial settlement patterns. The anisotropic propagation of material highlights the role of the natural channel system, and demonstrates that rather than extensive, artificial irrigation networks, served as the primary conduits for agricultural development among larger communities. In this regard, there are signs of more intensive cultivation in the more populated Area 1 where, as indicated in section 5.6, some evidence of cultural material occurred in the upper levels of the test pits. Lisitsina (1973) has suggested that cultural material may occur in the top 30 or 40 cm of takyr soils in cultivated areas, and it is possible that, although manuring is likely not the primary explanation for the larger sherd scatters on takyr surfaces (see above), that such processes may have contributed to the subsurface material in Area 1 not clearly associated with direct occupation.

While agricultural activity and significant occupation propagated along the channel systems, the complexity of the sherd distribution even in low density areas not directly associated with the fluvial system suggests that these regions were active as well, but that the nature of such activity was very different. Sherd aggregations in these regions are far more variable, and anisotropic signatures much more difficult to identify. Moreover, the current geomorphology of the landscape takes on a more prominent role in the archaeological recovery of these regions. However, as discussed earlier in this chapter, the continued presence of archaeological material suggests that scatters resulted both from local mobility associated with the pastoral activities of a mixed economy (see discussion in section 7.4), as well as from small-scale but opportunistic occupation facilitated by intermittent and shifting fertile zones. Cazancli (2002) has modelled the behaviour of floodwaters in alluvial fans, finding that lateral erosion and channel shifts upstream may result in the constant reshaping of the distal regions. It is likely that the interfluvial environment thus offered both promise and risk for smaller-scale occupation and cultivation while the primary channels remained, at least for a time, more stable and suitable for larger scale settlement.

It is worthwhile to briefly address these complexities of the sherd distribution in the context of the purported geomorphological and climatic changes that occurred towards the beginning of the second millennium, outlined in Chapter 2. Much of the recent examination of the relationship between climate and culture change has shifted away from grand-scale explanations (see Rosen

2007), focusing instead on local and regional responses to climatic variation. Possehl, for example, has questioned the view proposed by Weiss (1993) that precipitous climatic changes in northern Mesopotamia, by weakening demand for resources in southern Mesopotamia, ultimately contributed to economic decline on the Indian subcontinent (Weiss 1993). While acknowledging that socio-economic and climatic factors likely played a role in the Indus decline, Possehl prefers to examine these on more local and regional levels. He focuses on the disappearance of the Saraswati River, a currently dry riverbed along which a substantial number of Indus settlements were discovered (Possehl 1997), as a more likely culprit in the dissolution of societies in that region. Elsewhere in the broader region, Stein (1925) has documented the presence of settlements far beyond the current oases in the Lop Nor region, and the desiccated environments of sites such as Shahdad (see above) offer further testament to regional desiccation and water loss that ultimately contributed to societal decline. Unfortunately, the NMDS survey data do not offer enough chronological resolution to adequately trace changes towards the end of the Bronze Age, but the apparent southward shift in Namazga VI material in Area 1 (see section 5.8) may indicate a reorientation of the settlement pattern. Viewed in conjunction with the apparently burgeoning development of the Adji Kui region during this period, this patterning may reflect larger scale change, not only locally, in response to an increasingly unreliable fluvial system (see Section 5.8, but also in response to a deepening centre of influence just to the south. It is tempting, in this light, to envision a slow movement of northern groups and new settlements into the central delta towards the end of the Bronze Age, a shift that would have been similarly constrained by the availability of water, and manifested ultimately in the continued clustered directionality of the settlement pattern.

7.10 Summary

This chapter has offered some interpretations of the settlement landscape through an integrated examination of the data presented in the previous three chapters. While surface material cannot act as a direct substitute for subsurface archaeology, there is a wealth of information available to provide informed speculation not only about settlement areas, but interactions and peripheral activities as well. Furthermore, the analysis has highlighted the need to consider the landscape in detail and at several scales of analysis, both in terms of material distribution and recovery potential. Through this approach, clear patterns have emerged that highlight the integrated nature of the various processes shaping the surface distribution. Furthermore, these patterns demonstrate the necessity in examining not only settlement processes, but post-depositional factors, concurrently. In this manner, it has become to not only understand the nature of settlement, but to understand the archaeological landscape as a coalescence of dynamic and continuous processes. These findings will now assessed as a whole, drawn together in the final chapter of this thesis.

Chapter 8. Lessons from the Black Sands: Methodological Issues, Conclusions and New Directions

From its inception this research has relied upon a fundamental assumption: that even in the adverse, obstructed archaeological landscape of the northern Murghab, a region that has for decades eluded substantial archaeological enquiry, innovative approaches to surface survey can shed new light on a little-known settlement landscape. To arrive at these realisations, the research embarked on several exploratory yet closely linked trajectories, joining more traditional aspects of transect-based survey with newer statistical and technological approaches to data acquisition and analysis. From a theoretical perspective, the research sought to unify concepts of spatial patterning, scale and landscape as a means to ultimately draw conclusions about a society from a heterogeneous patchwork of surface pottery.

8.1. Limitations of Research Methodologies

Before detailing the outcomes of the NMDS research, a critical assessment of the methodologies is necessary. Most of the approaches used in this research are new to the Murghab, and in some cases, as with the investigations of anisotropy (section 6.5) and visibility (section 4.3.3), they have rarely been applied in any archaeological investigations. Moreover, the complex nature of the northern Murghab landscape requires an evaluation of the methods not only in terms of general effectiveness, but also with respect to their applicability in this unique archaeological environment. The first consideration is the use of intensive survey as a tool for settlement pattern investigation. General problems associated with collection and counting of surface materials are well established (Mattingly *et al.* 2000) and the quantitative errors that may result from differences in skill, vision and perception among fieldwalkers were evident in the NMDS survey (section 6.5.1). Additionally, the pace at which transects were walked contributed to potential inaccuracies, and sherd counts became less reliable as material densities increased. As evidenced by the highly varied sherd counts in Area 1 (section 5.6.1), recorded totals in high-density collection units were subject to significant variation, a problem which was substantially reduced in lower density regions.

While such errors may complicate any survey, several factors were peculiar to the northern Murghab landscape, and resulted in an even greater potential for error than might be expected in other surveys. The prevailing north-south topography of the dune ridges often resulted in unintentional shifts of the walker lines. Although locations were repeatedly corrected, these may have at times affected the recorded sherd totals. There was also a general tendency for the eye to be drawn towards takyrs or depressions, where sherds were expected and potentially easier to spot. A related problem was the variation in sherd scatters. Tiny, abraded materials associated with sandy deposits at the edge of a depression could be practically ignored by one observer but seen as dozens of sherds by another. Attempts to work with the team to identify different kinds of scatters as they occurred were helpful, but often difficult because of communication difficulties due both to the different first languages of the surveyors and the 20m distance between them in the field.

A second issue concerned the chronology of the material. While the project was designed as a spatial investigation rather than a chronological one, the fact that Middle and Late Bronze materials did not exhibit substantially different spatial patterning meant that settlement change could only be indirectly inferred, not directly identified. While anticipated from the beginning of this research, the problem was initially expected to be one of chronological identification rather than ambiguous spatial patterning. With the exception of a possible shift in distribution from the Middle to the Late Bronze Age in Area 1 (see section 5.8.2), the coterminous occurrence of material from both periods in most of the major scatters indicated that fine chronological resolution could not easily be linked with the settlement pattern. Furthermore, this observation suggests that the predominance of Late Bronze material in small sites and transects observed by the AMMD researchers (Cattani and Salvatori 2008) may reflect the poor diagnostic character of material in the field rather than actual chronology. Ultimately, the strengths of the NMDS survey lay in spatial, not chronological, investigation.

Another set of limitations concerned the integration of remote sensing data in the survey. Since the initial survey design relied heavily on this data, certain initial assumptions about the northern Murghab landscape were necessary to launch the project, but these had to be modified during the course of the research. The first issue was a tendency to underestimate, prior to the actual fieldwork, the extreme complexity of the landscape. While this theme has been articulated repeatedly throughout the thesis (especially Chapter 4) and was recognised in principle from the beginning of the research, the planning of an intensive survey based in part on a visual interpretation of medium-resolution satellite imagery and abstract delimitations of

archaeological sites (section 3.2.2) carried some risk. Because ground-truthing could not be employed until the second year of the research, the placement of survey grids effectively relied on desk-based models of the archaeological landscape rather than a full understanding of the actual environment (refer to Adams and Gillespie 2006 for in depth discussion on these limitations). These problems were, however, effectively countered by the design of the pilot survey which facilitated modification of the overall survey design should it have been required. Moreover, the simplistic but easily identifiable dichotomy between sand and takyr was readily apparent in the preliminary visual and multispectral analysis so that initial questions of material distribution in these regions could be addressed and subsequently refined.

Another issue pertained to scale, a concept that proved just as relevant to image analysis (see Atkinson 2004) as to the spatial patterning of material. While the ASTER imagery effectively identified general characteristics of geomorphology and land-use (section 4.2.4), and was useful in assessing the properties of the material distribution over broad land categories, its applicability at small scales was limited and the imagery could not be effectively employed to draw sound conclusions regarding isolated sherd scatters. Moreover, since the ASTER infrared bands offered only 30m spatial resolution, this information could not be extracted at the collection unit level. Conversely, the 0.6m-2.5m resolution of the Quickbird imagery, while offering a wealth of information about localised land cover, was often unnecessarily high for the raw survey data since landscape variations often occurred below the error threshold for individual sherd location. The apparent association of particular sherd distributions with small depressions, for example, was therefore potentially unreliable. By employing a multiscale approach to the remote sensing data, however, a useful compromise was attained through which to conduct an integrated study of material and landscape.

In terms of site identification, the applicability of remote sensing was limited due to two primary factors. First, the sheer number of 'false positives' hindered the systematic examination of these regions (section 4.5.2). Even when thresholds were extremely restrictive, there was no clear correlation between positive spectral hits and sites or sherd concentrations in the survey area. It was particularly noteworthy, in light of the intensive surface distribution in Area 1, that this region did not exhibit distinctive spectral characteristics as did the larger sites in the central delta. This suggests that a shifting, extensive rather than intensive occupation had less of an impact on the landscape. Furthermore, in the survey area, sites could not be identified based on spectral contiguity, a likely effect of the extreme variability over small areas. While problematic

in this particular area of the delta, the weaknesses of these particular remote sensing approaches were likely due to the absence of exposed and unmodified archaeological surfaces.

Spatial analysis, while useful in discerning broad statistical tendencies, was similarly limited by the extreme variability of the landscape. Significant topographical and material variation not only within the analytical units, but even within smaller statistically significant regions indicated strong spatial heterogeneity throughout the survey area which hindered sound statistical evaluation of truly homogeneous regions (section 6.4.2). Furthermore, the variations in sherd counts described above, while reduced via normalisation of the data, added additional error to the statistical evaluations. The anisotropic analysis (section 6.5) was subject to similar complications, and while general directional trends were clearly identifiable, the identification of individual localised processes was best suited to visual rather than statistical evaluation.

In a region where most of the methodological approaches are untested, these limitations become even more important when drawing final conclusions. Indeed, a perennial problem with Murghab research has been the failure to recognise such limits, and to draw overly large-scale conclusions often not substantiated by the few available points of analysis. The final sections of this thesis therefore provide a reflexive view of the methodology in order to develop a new understanding of the settlement pattern, and to provide a new set of interpretations and perspectives on the Bronze Age occupation of the northern Murghab.

8.2. *Outcomes in Settlement Interpretation in the Northern Murghab*

8.2.1. The NMDS Approach: Methodological Implications

As discussed throughout this thesis, the NMDS survey was conducted in response to some strongly entrenched and sometimes overly constraining theoretical frameworks with respect to the character of both the river delta and the associated distributions of cultural material. The current study navigated these constraints by taking an exploratory and innovative approach to the survey data, loosening the prevailing frameworks enough to allow the surface scatters to offer new perspectives on the northern Murghab settlement pattern and ultimately present the sedentary societies of the delta in a new light. The following discussion articulates the key

methodological outcomes as a precursor to broader conclusions concerning the nature of settlement and material distributions in the northern Murghab.

Firstly, the results of the survey clearly highlight the wealth of information that may be obtained from intensive survey, data largely unobtainable from more extensive approaches. The NMDS research provides clear evidence that the distribution of settlement and material in the northern Murghab is much more complex and varied than these older models suggest (sections 5.6, 6.4-6.5), and demonstrates the dangers of inferring settlement patterns from grand-scale, site-based surveys alone. Particularly in the Murghab, where visibility is extremely restrictive and sites not topographically prominent, cursory assessments of site sizes and numbers may be highly misleading (see section 6.1). Moreover, the variability of the sherd scatters in both high and low density areas illustrates the complex interplay of settlement, geomorphology and recovery bias, valuable information that had previously remained elusive. Indeed, if the aim of the current research had been simply to *find* archaeological sites, then the scepticism of archaeologists who question intensive and more quantitative approaches (e.g. Fentress 2000; but see discussion in Caraher et al. 2006; also see section 2.7) may have been more apt. Even the cursory coverage of this region by the AMMD researchers was sufficient to locate the largest scatters, and were the same resources applied here as elsewhere in the Murghab, many smaller aggregations would have been identified. These findings concur with Redman's (1982) observation that the intensification of a survey may not necessarily improve the recovery potential for large sites. However, Redman suggests that 'under ideal conditions one could probably identify a large mound site from 0.5km or more away...and within 50m to detect...a scatter of artefacts and no topographic anomaly' (Redman 1982). In the northern Murghab, a region riddled with such topographic anomalies, these qualifying words are profoundly relevant and strategies that address these issues are therefore essential. By narrowing the scope of survey it has become possible to detect not only scatters, but, even more importantly, patterns of distribution hitherto undetected in extensive surveys.

Secondly, the NMDS survey demonstrates the importance of a multi-scalar approach that in conjunction with the wealth of data provided by the earlier Italian and Russian projects (see treatment in sections 5.6.1, 6.2, 7.8), facilitated the interpretation of local and regional settlement patterns. While the concerns regarding the applicability of small-scale surveys to regional questions (see section 2.7) are well-intentioned and, in many contexts, fully valid, there is a great deal to be learned about both settlement and post-depositional processes at small scales that, if properly integrated with broader regional knowledge, can offer a wealth of information that may

not otherwise be attainable. Furthermore, the multiscalar approach has allowed the NMDS data to serve as a kind of methodological anchor against which to assess spatial patterning elsewhere in the delta. The methods used in this research are definable, repeatable and transferable, and may therefore be used to explore local processes in different areas that can ultimately strengthen the multi-scalar understanding of the entire region.

Thirdly, the broadening of traditional survey methodologies to include both remote sensing and spatial analysis has facilitated a series of new interpretations often not discernible through field methods alone. By offering full and quantifiable depictions of both the sherd distribution and the land cover, it was possible to obtain a much deeper understanding of visibility (section 4.3.3) and topography. Furthermore, inferences could be drawn concerning the relationship between complex sherd scatters and the dynamic geomorphological processes that contributed to the surface distribution (sections 6.5, 7.4.2). The further integration of spatial dependence and anisotropic analysis clearly demonstrated that while recovery biases and post-depositional processes were substantial (section 6.5), important archaeological conclusions could be drawn about settlement in the Murghab, explored in detail in Chapter 7 and revisited below. These findings partially counter Cattani's contention that, due to the visibility problems 'there was no possibility of developing any reliable reconstruction of the agricultural landscape or of drawing a population estimate from the settlement data' (Cattani et al. 2008a: 43), while continuing to agree with the general point that these extrapolations are difficult. In fact, the outlook for such interpretation is made brighter if we examine the data at several concurrent scales of analysis, as this allows us to address more comprehensively the multiple facets of material distribution from settlement process to final deposition (cf Bevan and Conolly 2006).

The investigation of both anisotropic and aggregational variability in the surface distribution is therefore an essential aspect in the identification of processes that have influenced the final deposition. Equally important, however, is an understanding of the lenses through which the surface material is interpreted, as they profoundly influence the way the surface scatters appear to the observer and must be deconstructed accordingly. In this regard, the use of remote sensing to identify both the inherent anisotropy of the landscape and the character of land cover, each at multiple analytical scales, was pivotal. The biases that result from directional landscapes, as well as their interpretative potential, are too influential to be overlooked, and it is important to assess these factors prior to undertaking many field projects. Moreover sampling strategies may benefit by taking directionality into account, and it is important to recognise where sampling

may inadvertently be affected by directional continuity or discontinuity, discussed in more detail below.

The fourth methodological outcome is a reassessment of the concept of ‘site’ in the context of the northern Murghab archaeological landscape. If by site we mean a discrete aggregation of surface material that broadly represents an actual settlement location, then the notion is not particularly useful in the context of intensive survey in this region (also see discussion in section 2.7). Post-depositional processes have shifted or obstructed material, and the discrepancy between surface scatters and subsurface archaeology indicates that the delineation of discrete occupational areas is unreliable (section 5.6). Moreover, there is no reason to assume that actual settlements in antiquity were strictly delimited. Broad surface scatters may reflect outlying occupations, for example, while anisotropic patterning may indicate activities associated with agriculture or irrigation along watercourses. Moreover, occupation may have slowly shifted, with individuals, families or groups relocating either in tandem with shifting watercourses or possibly further upstream as agricultural potential on the northern fringe of the delta slowly deteriorated. Such behaviours are only very imperfectly captured by the conventional notion of an archaeological site. Thus, while the concept may still be useful at larger analytical scales, its value progressively weakens as the complexity of the material distribution comes into greater focus. Nevertheless, some choices still have to be made concerning those regions that warrant further study and those that do not. In this regard, the best candidates for ‘sites’ were generally broader regions of high spatial clustering (section 6.4.3), often comprising sandy depressions or eroded takyr surfaces, and characterised by sherds of varied sizes, the presence of diagnostic material and occasionally by topographical variation (cf ‘tepe 1’, ‘tepe 2’ and ‘elevated density areas’ in Bondioli and Tosi 1998).

8.2.2. An Interpretative Model: A Landscape of Clustered Directionality

Rivers and Directional Continuity

Having articulated the methodological advances of the NMDS survey, some conclusions may now be drawn about the nature of the surface distribution itself. To provide a framework for this discussion, a re-assessment of the ‘continuous landscape’, described in section 7.4, is necessary. As discussed in sections 2.4 and 7.4, the AMMD model of a continuous settlement landscape provides a much more appropriate model of Murghab occupation than does the prevailing ‘oasis’ model, particularly in demonstrating that much more of the landscape was potentially available

for settlement and land-use than had previously been described. However, the NMDS work has highlighted some major constraints to this continuity. Of paramount significance is the demonstration that the distribution of neither settlement nor material is uniform. As discussed in the previous chapter and in section 6.4, surface distributions behave very differently in different directions. The primary determinant in this regard is the channel system (section 7.7), and the constraining influence of channel availability directly influenced the linearity of the settlement pattern. Surface distributions along these fluvial corridors exhibit clear signs of clustering, with a degree of regularity that suggests that the small occupations along river channels were broadly similar in size and influence. Larger communities existed, as evident in Area 1, but the overall appearance of the settlement pattern reflects common structural characteristics in high and low density areas along the watercourses. Communities aggregated in some regions more so than others, for reasons primarily associated with the availability of water and fertile land, particularly in the marginal and tenuous agricultural environment of the northern Murghab (sections 7.8-7.9). Post-depositional processes in these regions have a directional component as well, and the apparent conveyance of material in similar directions as the chains of high density clusters highlights a fluvial component to the redeposition of materials, both from actual channel flow in antiquity as well as more recent rainfall events that continue to transport material along exposed areas of relict channels. Additionally the cultivation of soils, broadly but not entirely constrained to the channels, likely followed a similar trajectory (sections 7.6-7.7) and, in conjunction with erosional processes, may have contributed to the continuous distribution of small fragments in these regions.

The Wider Landscape and Directional Discontinuity

If the watercourses influenced settlement, agriculture and post-depositional processes along the main channels, a completely different story has emerged in regions more removed from these channels. In these low-density areas, settlement continuity is much more irregular and the anisotropic patterning harder to read. Here, the initial deposition of material was partially attributable to transient occupation and mobility associated with pastoral activities (see discussion in section 7.4). Additionally, opportunistic agricultural activity played a role, and may reflect the cultivation of areas that may not have been directly channelled but still fertile, the result of unpredictable fluvial processes in the delta fringe (section 7.8). In this vein, we must also consider the possibility that small scatters may also be associated with small transverse irrigation channels, undetectable in the deflated landscape, which may extend substantially beyond the primary channels. Wilkinson (2003a: 71) suggests that, through direct processes of

canal construction and land-clearance as well as indirect effects caused by erosion and silting, even small-scale, localised irrigation strategies may shape distributions. It is likely that many, if not all, of these factors were in play in the NMDS landscape. Ultimately, however, these processes only account for the presence of material—they do not fully predict which processes caused each individual sherd scatter. While the larger aggregations likely represent heavily modified archaeological processes, the actual location of material, and particularly the small, clustered sherd scatters, are more likely attributable to immediate and localised geomorphological processes. In these cases, sherds, affected both by wind deflation and water erosion, tend to aggregate in low-lying areas and may not directly reflect settlement at all (cf Cleuziou 1998).

8.2.3. Contributions of the NMDS survey to settlement analysis

On a broader scale, the anisotropic landscape of the NMDS survey clearly reveals that while structured continuity is an important characteristic of the settlement pattern, this does not imply that the entire landscape was fully accessible, or utilised in a uniform manner. The extreme variability in the surface distribution shows that the dichotomy between the oasis model (section 2.4.1) and the AMMD model of a fertile alluvial plain (section 2.4.2) is overly simplistic, and neither interpretation fully captures the development of settlement in what was likely a region of significant environmental and geomorphological transition. The already marginal environment towards the distal portion of the delta (see section 7.8), offered comparatively restricted opportunities for settlement establishment and development when compared with the central delta, and the decrease in later material suggests that the situation became even more tenuous into the second millennium. Moreover, while water was readily available even in the northern fringe of the delta, its exploitation did not match the scale of major hydraulic societies such as southern Mesopotamia, and large artificial canals that may signify transportation and state-sponsored water management (Adams 1965) were not in evidence in the northern Murghab. Nonetheless, there were still ample opportunities for communities to exploit a landscape that was at once adverse and productive, as reflected in a complex occupational landscape that clearly adds a great deal to the previous interpretations of the Egri Bogaz region.

By exploring the non-uniformity of the material distribution, the NMDS research has provided an analytical framework that addresses local and regional variability, and can now offer interpretations as to how communities may have developed and functioned. Initial settlement locations, often representing the appearance of kin or kin-based groups in the delta, were largely

influenced by resource availability, although, as Anthony (2000) notes, other factors such as the presence (or absence) of other groups in the area may also have influenced where people chose to settle. These settlements provided the initial clustered anisotropy that continues to define the settlement landscape. Development of these communities comprised a series of processes, vestiges of which can be seen in the complexity of the sherd distribution. Economic strategies likely involved individual, kin or community-based control of various aspects of a mixed economy, including the management of fields and herds as well as irrigation canals, and the vestiges of these practices, albeit heavily modified by post-depositional processes, may be seen in the sherd distribution. The primacy of the local economy may also be seen in the sporadic but identifiable evidence of production, evident in the substantial quantities of vitrified brick and metal, particularly in Area 1 (section 5.6.1). This distribution recalls concentrated production areas at sites such as Gonur (Sarianidi 2002a), Adjı Kui (G. Rossi-Osmida, pers. comm.) and Taip (Kohl 1984: 150) as well as sites in Bactria (Kohl 1984: 150), and strengthens the argument for production at the local level.

The complexity of the material distribution beyond the clustered large scatters is thus a testament to the dynamism of local development in the northern Murghab. Neither fully restricted to oasis-based micro-environments, nor completely unconstrained, the surface distributions indicate a complex and predominantly local exploitation of an often unreliable landscape, one that ultimately yielded to a conjunction of increasingly adverse environmental and socio-economic circumstances, most significantly an increasingly unreliable fluvial regime and consequent decrease in productivity. Dispersed scatters and, occasionally, low settlement mounds reflect an organic, unstructured approach to settlement and agriculture, perhaps indicating the need of families or communities to locate more fertile land or stable sources of water, fairly rapid changes that took place over years rather than generations.

For all that may be inferred about settlement development, distribution and land use, the surface distribution of today ultimately represents nearly four millennia of change that has drastically reshaped the initial settlement distribution, both smoothing and punctuating it into a continuum of sherds that represent a highly stylised picture of the original settlement pattern. While settlement-derived activities offered early modifications to the initial distribution, these were further shaped over time by erosion and deflation, modified by wind, water and the chance interference of people and animals. This research thus speaks to the extreme dynamism inherent in what was once thought to be an extremely sparse archaeological landscape, and offers new insight into how such processes may be interpreted.

8.3. New Directions: Suggestions for Further Research

This research has sought to illuminate a shadowed landscape and provide a step forward in our understanding of broader settlement processes in the northern Murghab. Each aspect of the settlement pattern that has come into greater focus has suggested new avenues of potential research, both in theory and method. From the perspective of survey, there is an entire delta that remains to be explored in greater depth, and the NMDS research has suggested new methods and interpretative frameworks for that exploration. Clearly, the integration of the northern delta into broader Murghab investigations must continue. Reliance on the Kelleli region is not sufficient to unravel the mysteries of the north, and the success in investigating the settlement complexity of the Egri Bogaz region demonstrates that even in this obstructed landscape, a great deal of archaeological information is accessible. Certainly, further excavation is necessary, and an intensive programme of subsurface investigation would be useful in establishing a much-needed chronology for this region. From a geomorphological perspective, a targeted investigation of the hydrological system in the north would greatly enhance the understanding of the relationship between water and settlement at the local and regional levels. Beyond the limits of the known occupational sphere of the delta, there is clearly a role for both spatial analysis and remote sensing, and perhaps these may be effective at larger scales to identify more elusive evidence of occupation beyond the known delta fringe. To this end, investigations of the far north and east of the Murghab delta, as well as the largely unstudied region between the Murghab and Tedjen, are greatly needed.

In a region so heavily defined by unknowns, every contribution to archaeological knowledge runs the risk of becoming overemphasised, a research beacon that exerts undue influence in the absence of substantive background data. As suggested in the opening chapter, this is a problem that plagues the Murghab, where a few sites are too often seen to represent the entire delta. In reality, every scale of analysis offers new and different information and the integration of these is fundamental to understanding not only the main areas of occupation, but the delta as a whole. Whether or not the Murghab Bronze Age really does represent a ‘New Centre of World Civilisation’, it certainly needs a better sense of perspective. This outlook was the underlying theoretical motivation behind this research, and its realisation in the field via the deliberately integrated assessment of settlement patterning, scale and wider landscape represents the main contribution of this research.

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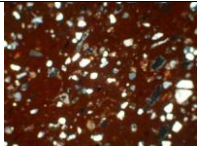
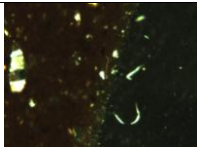
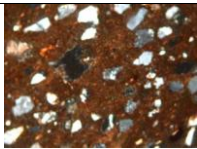
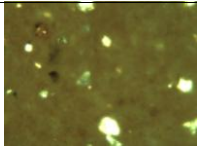
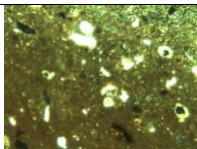
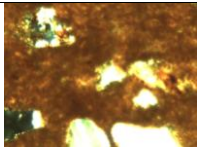
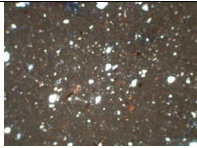
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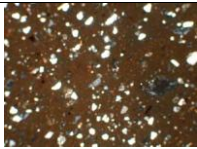
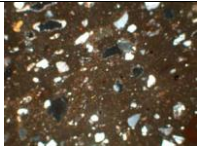
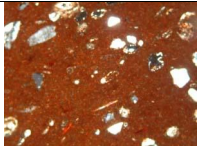
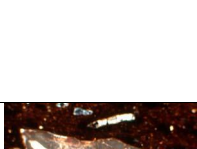
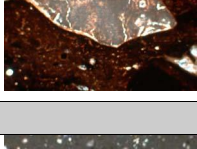
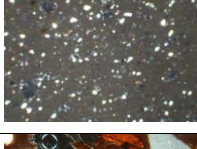
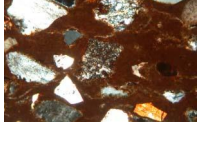

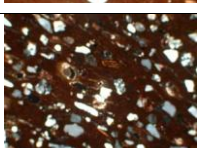
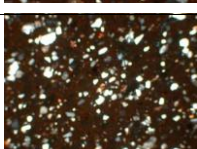
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Appendices

Appendix A: Petrographic Analysis

ID	Square	Matrix Colour	Thin Section Image. 10x magnification	Period	Quartz (%)	Quartz Grain Size (mm)	Natural Inclusions	Temper	Comments
1	C55	Reddish		Bronze	15	.1mm	Biotite mica (1% Plagioclase feldspar (1%))		
2	Area 1 (not part of survey)	Red- brown		Sas-Isl	8-10	.1mm	Biotite mica (2- 3%), plagioclase feldspar (<1%), granite (<1%)		Slightly heavier mica content, significant calcium carbonate agglomerates
3	C63 (external)	Red- Brown		Middle Bronze	20	.2mm	Plagioclase feldspar Biotite mica		Very rich, heavy feldspar, granite inclusions, possible chaff
4	C63b	Red- brown	n/a	Late Bronze	20%	.15- .2mm	Plagioclase fedspar (1%), biotite mica (1%)		Calcium carbonate in voids
5	344	Brown		Bronze	5%	.15mm			
6	342	Med- brown		Bronze	10%	.15mm ,	Biotite mica (1- 2%), Small amounts of plagioclase and microcline feldspars		Small voids, occasional calcium carbonate agglomerates
7	343	Red- brown		Bronze	15- 20%	.2mm	Biotite mica (1- 2%), plag. Feldspar (occ), small granite chunks (0.2mm)		Clear alignment to quartz grains, reflective of wheel-thrown pottery Poorly sorted.
8	C64	Grey		Bronze	5%	.1mm	Biotite mica (<1%) Plag. Feldspar (<1%)		Round aggregations of calcium carbonate

9	C53	Red-Brown		MBA	5-10%	.15mm	Large quantities of biotite mica, plagioclase/microcline feldspar		
10	C54	Brown		Bronze	5-10%	.15mm			
11	C62	Red		Bronze	10-15%,	.2mm	Biotite mica (1-2%), plagioclase feldspar (<1%), granite (1-2%)		Calcium carbonate, often surrounding quartz grains. Possible mixture of clays?
12	C29	Dark Brown			<5%	.1mm	Quartz nearly absent	Flint inclusions	
13	discarded								
14	C33	Grey		LBA	5-10%	.1mm			
15	D-70 (1)	Red-Brown		Bronze	40%	.25mm	Plag. Feldspar (2%) Microcline feldspar (<1%) Clinopyroxene	Possible alluvial sands	Quartz nearly absent in fine matrix. Perhaps drained in production
16	D-70 (2)	Red-Brown		Bronze	10%	.2mm	Plag. Feldspar (2%) Microcline feldspar (<1%)		
17	D-70 (3)	Brown		Bronze	12%	.15mm	Plag. Feldspar (trace) Biotite mica (1%)		
18	D-70 (4)	Brown		Bronze	15%	.1mm	Plag. Feldspar (1%) Biotite mica (1%)		
19	E-32	Red-brown		Bronze	.5%	.15mm		Grog	

Appendix B: Selected Small Finds



Terracotta Spindle Whorl

**Square F-78
Line 10
Segment 10**



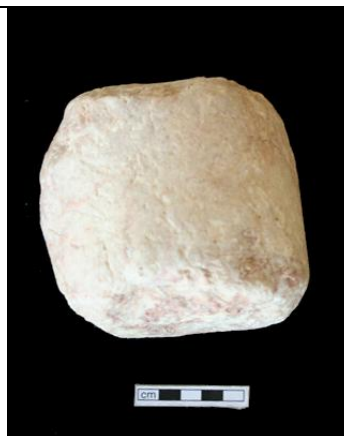
Terracotta Spindle Whorl

**Square M-76
Line 30
Segment 10**



Stone

**Square L-17
Line 90
Segment 90**



Stone (Alabaster or Calcite)

**Square H-9
Line 10
Segment 30**

:



Stone (Onyx)

**Square G-82
Line 30
Segment 70**



Stone (Carnelian)

**Square 5/6
(isolated find not recovered as part
of survey)**



Copper or Bronze Axe Head

**Square M-86
Line 70
Segment 30**



Terracotta Figurine

**Square L-63
Line 30
Segment 10**



Terracotta Figurine

Area 1 (not recovered as part of survey)



Terracotta Figurine

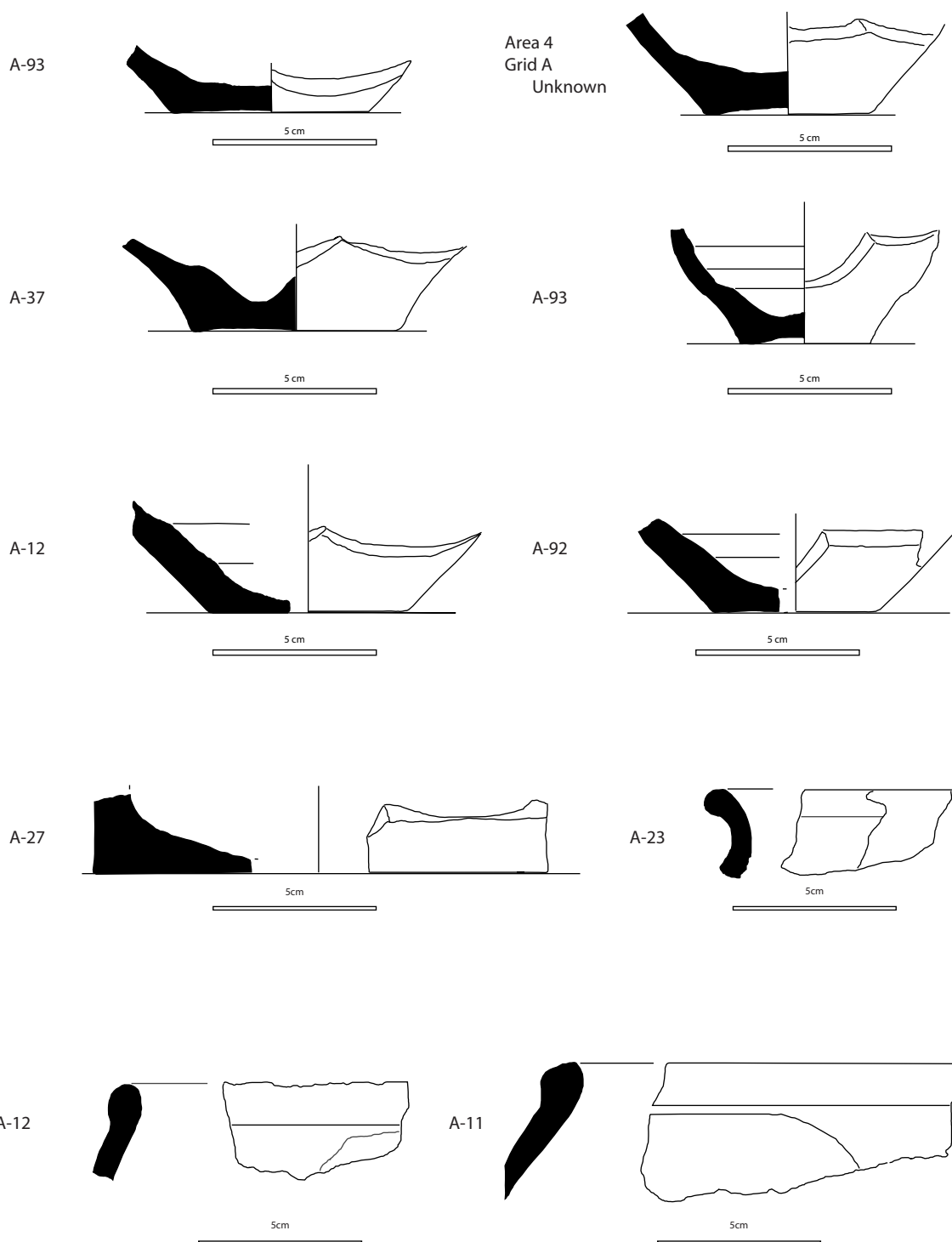
**Square CW-09
Line 30
Segment 30**



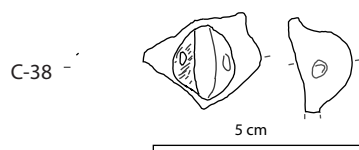
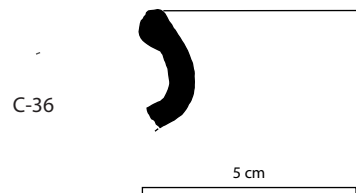
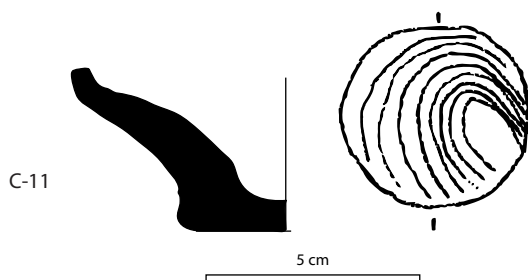
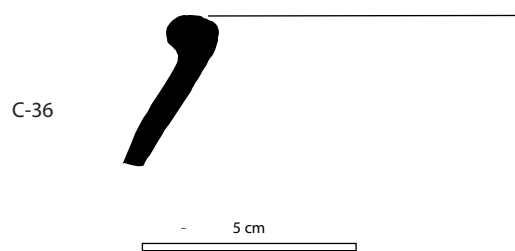
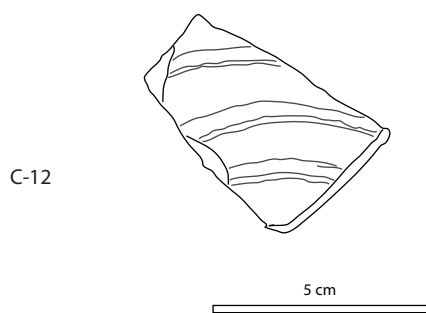
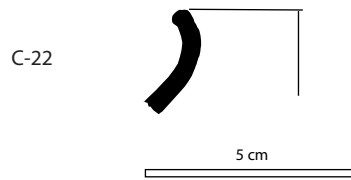
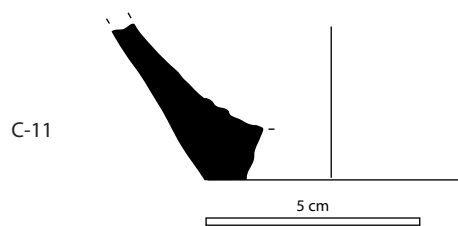
Stone

**Square 62
Line 30
Segment 30**

Appendix C: Drawings of Selected Surface Sherds

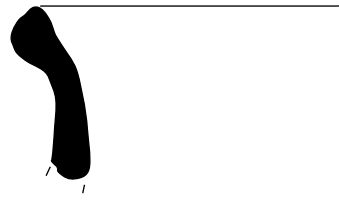


Illustrations by Luana Cenci



Illustrations by Toby Wilkinson

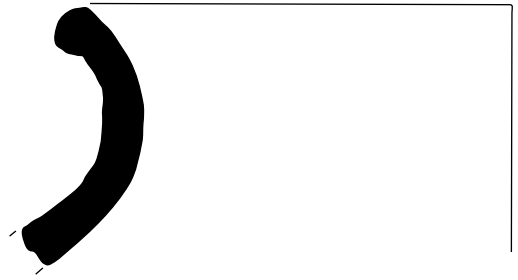
C-22



5 cm



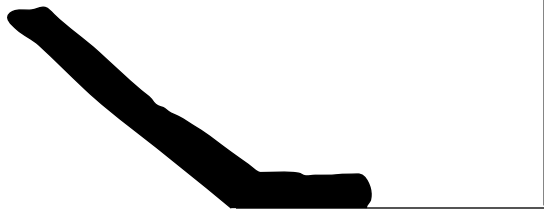
C-28



5 cm



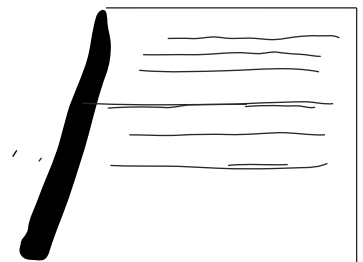
C-22



5 cm



C-28



5 cm



C-23

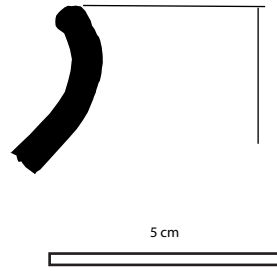


5 cm

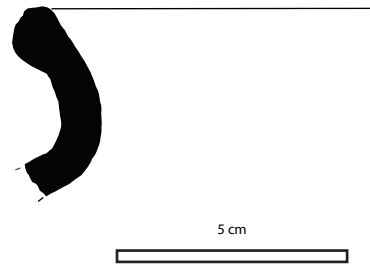


Illustrations by Toby Wilkinson

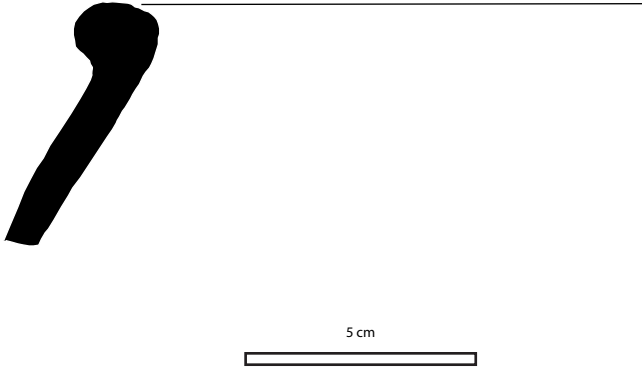
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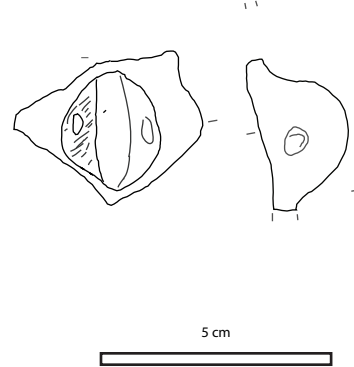
C-36



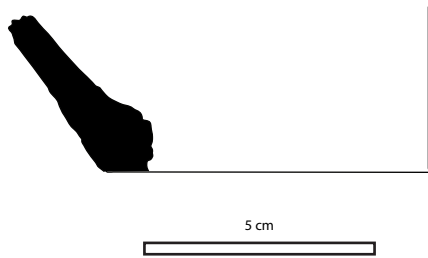
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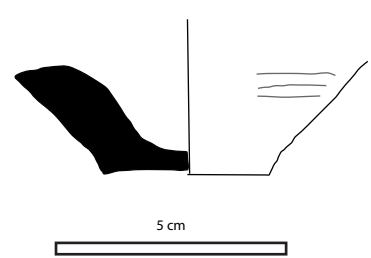
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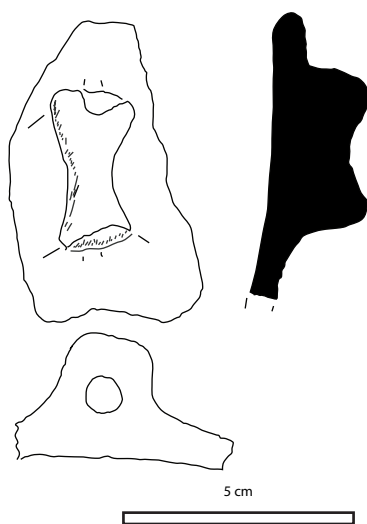
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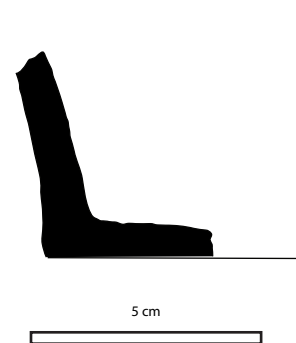
C-14



C-12

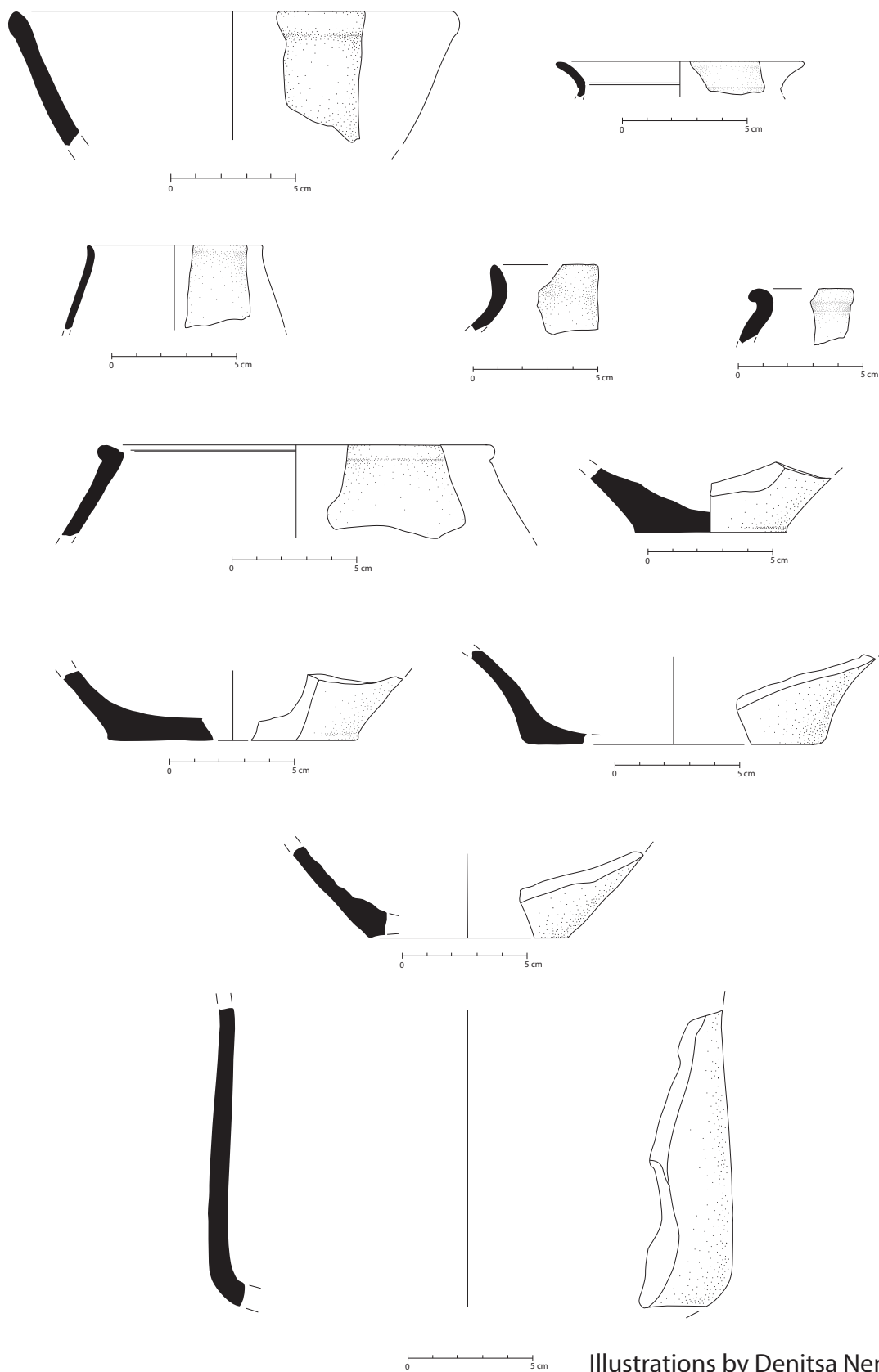


C-11



Illustrations by Toby Wilkinson

Sherds from D-70



Found in Area 1 near pipeline
(not during survey)

